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Molecular data support the Atelurinae and Coletiniinae as sister groups: a second *Lepidospora (Brinckina)* species (Zygentoma: Nicoletiidae: Coletiniinae) from the Pilbara

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ABSTRACT – 28S and COI sequence data support the suspected closer relationship of the Atelurinae to the Coletiniinae rather than other subfamilies of the Nicoletiidae. A new species of silverfish *Lepidospora (Brinckina) maceveyi* sp. nov. is described from deep subterranean habitat of north-western Australia.

KEYWORDS: Thysanura, troglobite, new species

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INTRODUCTION

Silverfish of the family Nicoletiidae are found in soil-related or subterranean habitats such as caves or else found as inquilines with ants or termites. They lack eyes and pigment. Sampling of the deep subterranean habitat via mining exploration drill holes has revealed a diverse subterranean invertebrate fauna (e.g. Guzik et al., 2010) and several papers (Smith et al., 2012; Smith & McRae, 2014) have described various nicoletiid species (Atelurinae and Subtrinemurinae) from this habitat. The first Australian representative of the subfamily Coletiniinae, *Lepidospora (Brinckina) relicta* Smith & McRae (2016), was described from a drill hole in the Pilbara, with the authors noting that further species had been collected and awaited description. This paper describes a second species of *Lepidospora* (*Brinckina*) Wygodzinsky, collected from a deep subterranean habitat more than 200 km from the previously described species. Nuclear and mitochondrial DNA sequence data has been obtained for this new species and for five additional genera of Nicoletiidae, to consider relationships within the family.

Our understanding of nicoletiid phylogeny has evolved greatly in recent decades. Lubbock (1873) split the silverfish into two groups on the basis of the presence of scales. He included the only then-known unscaled (and eyeless) silverfish, *Nicoletia phytophila* Gervais, 1844, along with the Diplura in his Nicoletiadae. He included the inquiline *Atelura formicaria* von Heyden, 1855, among the inquiline Lepismatidae, because there was some confusion in the early days as to the presence of eyes and, no doubt, due to the tear-drop shaped body and shortened terminal filaments which seem to be a general adaptation to life as an inquiline. With more silverfish being described and more eyeless forms being discovered, a different picture began to emerge. Escherich (1905) split the silverfish into three subfamilies viz, the scaled and eyed Lepismatinae, the unscaled but also eyed Maindroniinae and the eyeless Nicoletiinae, the latter group including the genera *Nicoletia*, *Atelura* (all eyeless inquiline species which also happen to be scaled), *Trinemophora* Schäffer, 1897 (unscaled) and *Lepidospora* Escherich, 1905. This latter genus had the body shape of *Nicoletia* and *Trinemophora* but was also covered in scales. Meanwhile Silvestri, a most prolific and talented taxonomist, continued to describe numerous new species and genera of Nicoletiinae without elaborating a phylogeny for the group. Remington (1954) raised the Nicoletiinae to family level, creating a subfamily Atelurinae for the inquiline forms. Paclt (1963) in a large work based largely on literature, maintained Remington's system but revised many of the genera, which received a good deal of criticism by Wygodzinsky (1963).

Mendes (1988), while considering the Ateluridae as a separate family, split the remaining Nicoletiidae into five subfamilies viz, Nicoletiinae, Coletiniinae, Cubacubaninae, Subtrinemurinae and Protrinemurinae. Irish (1990) examined the phylogeny of the Zygentoma and could find no

reason to exclude the Ateluridae from Nicoletiidae. Mendes (2002) analysed key characters of the Nicoletiidae and agreed with Irish. He included the Atelurinae as a subfamily within the Nicoletiidae and removed the Protrinemurinae, which he raised to family level. He also noted the close relationship between the Coletiniinae and Atelurinae which have separated coxites IX in the males (a character shared with the Lepismatidae, Maindroniidae and Tricholepidiidae) while all other Nicoletiidae subfamilies have these coxites fused into a single urosternite.

Apart from the extensive work of Espinasa with the Cubacubaninae and Nicoletiinae, very little molecular data exist at the moment to test theories on phylogeny. Espinasa and Mendes (2013) did examine the 16S sequence of a species of *Lepidospora (Lepidospora)* from the United Arab Emirates finding the nearest relative for which they had data was a species of *Australiatelura* [Atelurinae] from Australia but expressed caution because of the lack of data available for other nicoletiids and the large genetic distance between the species (22.1%).

This study offers new DNA sequence data from both nuclear and mitochondrial genes, 28S ribosomal DNA (28S) and cytochrome *c* oxidase subunit I (COI) respectively, of the new species of Coletiniinae plus five species of Atelurinae belonging to the genera *Australiatelura* Mendes, 1995, *Crypturelloides* Smith and Veera-Singham, 2011, *Proatelura* Silvestri, 1916 and *Pseudogastrotheus* Mendes, 2003 and two species of Subtrinemurinae from the genus *Trinemura* Silvestri, 1905, and combines these data with COI sequences from Espinasa et al. (2007) for eleven species of Cubacubaninae from the genera *Anelpistina* Silvestri, 1905, *Prosthecina* Silvestri, 1933 and *Squamigera* Espinasa, 1999.

SPECIMEN COLLECTION AND PREPARATION METHODS

Specimens were collected from mining exploration drill holes using the methodology outlined in Halse & Pearson (2014) and stored in 100% ethanol.

The head and terminal segments were removed and held in 80% ethanol, the remaining body was then subjected to DNA extraction for one hour and then returned to 80% ethanol, after which the specimen was dissected and mounted on a single slide in Tendeiro solution. The removal of the head and posterior segment ensured that these important body parts were not degraded by DNA extraction.

A series of measurements of all specimens was undertaken according to the method described in Smith (2013). All silverfish specimens mentioned are mounted on slides and will be deposited with the Western Australian Museum, Perth.

Specimens were dissected in 80% ethanol using an Olympus SZ61 stereomicroscope and each mounted on a single slide using Tendeiro medium (Molero-Baltanás et al., 2000). Drawings were made with the aid of an Olympus CX31 binocular microscope fitted with a U-DA drawing attachment. Some twisting of macrochaetae was observed, but this was not as extensive as previously reported (Smith et al., 2012) when specimens were dissected in 100% ethanol.

Roman numerals are used to indicate abdominal segment number. The following abbreviations are also used: HW: head width (in millimetres); H+B: head and body length (in millimetres); L/W: length to width (ratio); PI, PII, PIII: legs of pro-, meso- and metathorax respectively. The term *macrochaetae* refers to the larger stronger bristles, *setae* refers to smaller thinner bristles (usually simple) and *setulae* to the very small setae. Terminology for the 'segments' of the antennae, terminal filaments and ovipositor follows that explained in Smith (2015) where the term *annulus* will be used for each single unit of the flagellum (excluding pedicel and scape), usually a widened region carrying a single ring of setae (but occasionally with a smaller secondary ring), *T-annulus* for each annulus bearing a trichobothrium, *interval* for the group of annuli between T-annuli with the T-annulus being the most distal annulus of the interval. For the terminal filaments and ovipositor, the term *division* is used for each "segment" defined by a visible suture, albeit often faint.

SAMPLING, DNA EXTRACTION, PCR EXTRACTION, PCR AND DNA SEQUENCING

DNA extractions were performed using the Bioline Isolate II Genomic DNA Kit (Bioline, Eveleigh, NSW) following the manufacturers' protocol with elution volume adjusted to 50–70 µL. The specimens collected directly into 100% ethanol were soaked in DNA extraction buffer containing proteinase-K at room temperature for one hour. The remaining cuticle was returned to 100% ethanol and later dissected in 80% ethanol and mounted on to slides using Tendeiro medium.

Polymerase Chain Reaction (PCR) amplification of the DNA barcode region of the mitochondrial COI gene used the primers and followed the method of Mitchell (2015). For the 28S rDNA D9–D10 region, we used primers 28S_8fm and 28S_11rm, which are 5'-M13-tailed versions of Machida and Knowlton's (2012) primers [28S] #8 and [28S] #11_RC, respectively. PCR conditions for both genes followed those reported in Mitchell (2015) for COI. PCR products were purified using ExoSAP and sequenced in both directions using ABI Big Dye Terminator v.3.1 chemistry by Macrogen Inc. (Seoul, South Korea).

DNA SEQUENCE ASSEMBLY AND PHYLOGENETIC ANALYSIS

Forward and reverse direction sequence trace files were assembled using Geneious v.10.2.6 (Kearse et al., 2012). DNA consensus sequences, sequence trace files, and specimen collection data were uploaded to BOLD (Ratnasingham & Hebert, 2007) where they

TABLE 1 Specimens and sequences analysed.

Higher Taxon	Species	Sample ID	Museum Accession	Locality (Australia unless stated)	28S GenBank Accession	COI GenBank Accession	Type status
Family: Lepismatidae							
Lepismatinae	*Lepisma saccharinum*				EU376048	KR141905	
Ctenolepismatinae	*Ctenolepisma longicaudatum*	gbs001836	K377675	Hobart	MK185707	MT674899	
	Thermobia sp.	gbs005947	K261349	Iran	MW377919	AF370848	
	Acrotelsella parlevar	gbs004624	K261103	Travellers Rest	MK185706	MT674895	Holotype
	Qantelsella louisae	gbs003917	T228755	Bladensburg NP	MK185709	MK185705	Holotype
Heterolepismatinae	*Heterolepisma buntonorum*	gbs004929	K261244	Knocklofty	KY951373	MF040923	
	Heterolepisma sclerophyllum	gbs001024	K260992	Broulee	KY951392	MF040943	Paratype
	Heterolepisma cooloola	gbs003353	K377748	Cooloola	KY951400	MF040952	
	Heterolepisma highlandi	gbs001119	K377604	Wee Jasper	KY951374	MF040924	Paratype
Family: Nicoletiidae							
Subnicoletiinae	*Trinemura callawae*	gbs001127	E82755	Yarrie Station	MW377922	n/a	Holotype
	Trinemura cundalinae	gbs001631	E82692	Yarrie Station	MW377918	MW377896	Holotype
	Trinemura cundalinae	gbs001638	E82699	Yarrie Station	MW377915	MW377894	
Atelurinae	*Australiatelura eugenanae*	gbs003075	F14809	Eugenana	MW377917	MW377895	Paratype
	Australiatelura tasmanica	gbs001848	K261026	Mt Nelson	n/a	MW377897	
	Australiatelura tasmanica	gbs001418	K261020	Hobart	MW377921	n/a	
	Pseudogastrotheus undarae	gbs001303	K377717	Undara	MW377911	MW377891	Paratype
	Crypturelloides mindeni	gbs001006	K260960	Penang, Malaysia	MW377913		Paratype
	Proatelura sp. nr. *jacobsoni*	gbs004615	K377940	Taiwan	MW377912		
Coletiniinae	*Lepidospora (Brinckina) maceveyi* sp. nov.	gbs006143	E108517	Eliwana	MW377920	MW377898	Paratype
	Lepidospora (Brinckina) maceveyi sp. nov.	gbs006144	E108514	Eliwana	MW377914	MW377893	Holotype
	Lepidospora (Brinckina) maceveyi sp. nov.	gbs006145	E108515	Eliwana	MW377916	n/a	Paratype
Cubacubaninae	*Prosthecina avita*			Mexico		DQ280147.1	
	Prosthecina silvestrii			Mexico		DQ280148.1	
	Anelpistina boneti			Mexico		DQ280137.1	
	Anelpistina mexicana			Mexico		DQ280145.1	
	Anelpistina sp. Iglesia			Mexico		DQ280138.1	
	Anelpistina sp. Naranjo Rojo			Mexico		DQ280139.1	
	Anelpistina sp. Chiapas			Mexico		DQ280146.1	
	Anelpistina negreai			Antilles		DQ280141.1	
	Anelpistina puertoricensis			Antilles		DQ280142.1	
	Anelpistina puertoricensis			Antilles		DQ280143.1	
	Squamigera latebricola			Mexico		AY084070.1	

are accessible as public dataset DS-ZYLEP (dx.doi.org/10.5883/DS-ZYLEP). Sequences newly derived for this study were also deposited in GenBank (accession numbers, 28S: MW377911–MW377922, COI: MW377891–MW377898). Table 1 lists the museum, BOLD and GenBank accession numbers. Outgroups were selected from the authors' previously published studies (Smith et al., 2019) and from GenBank. COI sequences for Nicoletiidae (Cubacubaninae) were previously published by Espinasa et al. (2006). Although that study included 28S sequences they were from the D3 expansion region and do not overlap with the D9 region we use in this and previous studies.

Consensus sequences were aligned by eye. Regions of the 28S gene which could not be reliably aligned were excluded from the final data sets. Three data sets were constructed: 28S (20 sequences), COI (28 sequences), and all data (31 sequences, of which 17 were concatenated COI and 28S, 3 were 28S only, and 11 were COI only).

FABOX v. 1.5 (Villesen, 2007) was used to edit sequence names. Phylogenetic analyses were performed on the CIPRES Science Gateway v3.3 (Miller et al., 2010). Partitionfinder v.2 (Lanfear et al., 2016) was used to select a partitioning scheme and the most appropriate models for the COI and combined gene data sets. For both data sets this was two data partitions: third codon positions of COI versus all other sites, using the GTR+G model. Phylogenetic analyses were performed by Bayesian Inference (BI) using MrBayes 3.2.7a (Ronquist et al., 2012) and under Maximum Likelihood (ML) using RAxML v8.2.10 (Stamatakis, 2014). The BI analysis was set to run for 30 million generations, with a sample frequency of 1,000, using two runs, setting the number of chains to four. The stopping rule was used to end the analysis when the average standard deviation of split frequencies dropped below 0.01, indicating convergence of the chains. The burnin fraction was set to 0.25. ML analysis used the hill climbing algorithm with 1,000 rapid bootstrap replicates. All trees were rooted between the nine Lepismatidae outgroup taxa and the Nicoletiidae.

RESULTS

MOLECULAR DATA

Figure 1 shows the Bayesian tree for the data set comprising all 31 taxa. There is strong support (Bayesian posterior probability ≥ 0.9 and ML bootstrap percentage ≥ 70) for the monophyly of Nicoletiidae, and for the placement of Subnicoletiinae as sister-group to the remaining nicoletiids. There is also strong support for the monophyly of Cubacubaninae, Atopatelurini and Atelurini. Atelurinae is rendered paraphyletic by the placement of *Lepidospora* (Coletiniinae) as sister-group to Atelurini, however this relationship is not strongly supported. ML analyses of this data set, and both Bayesian and ML analyses of the single gene data sets, yield closely similar results, with variations only in the relatively weakly supported relationships among Atopatelurini, Atelurini and Coletiniinae.

SYSTEMATICS

Family Nicoletiidae Lubbock, 1873

Nicoletiadae Lubbock 1873: 201.

Gymnodermata Joseph 1882: 25.

Nicoletiinae Lubbock: Escherich 1905: 36.

Nicoletiidae Lubbock: Remington 1954: 284.

Subfamily Coletiniinae Mendes, 1988

Coletiniinae Mendes, 1988: 768.

Lepidospora Escherich, 1905

Lepidospora Escherich 1905: 131.

TYPE SPECIES

Lepidospora braueri Escherich, 1905, by monotypy.

Lepidospora (*Brinckina*) Wygodzinsky, 1955

Lepidospora (Brinckina) Wygodzinsky 1955: 179.

TYPE SPECIES

Lepidospora (Brinckina) makapaan Wygodzinsky, 1955, by original designation.

Lepidospora (Brinckina) maceveyi Smith & Mitchell, sp. nov.

Figures 2–33

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MATERIAL EXAMINED

Holotype

Australia: ***Western Australia*:** ♂ (HW 0.83), Eliwana EW0103 (22.473925°S, 116.825045°E), 22 March 2019, H.L. Clark, M.K. Curran, scrape method to 22 m depth (WAM E108514) on single slide.

Paratypes

Australia: ***Western Australia*:** ♀ (HW 0.65), same data as holotype (WAM E108515) on single slide; ♂ (HW 0.73) Eliwana EWMS0006 (22.483954°S, 116.865833°E), 21 February 2019, J.S. Cocking, G.B. Pearson, scrape method to 30 m depth (WAM E108517)

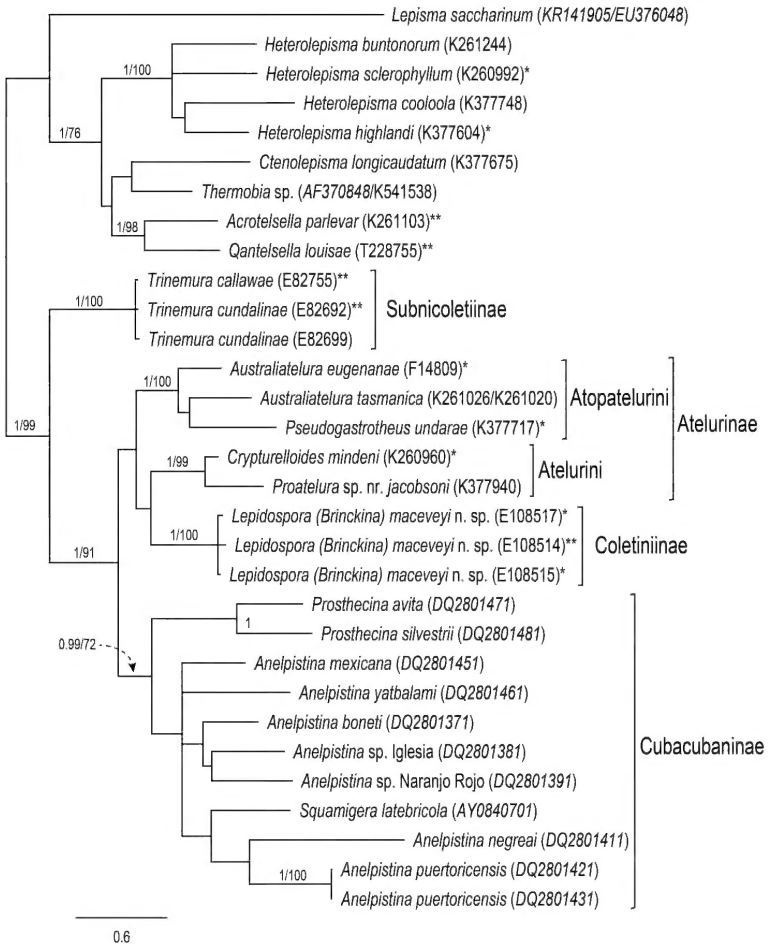


FIGURE 1 Bayesian tree from analysis of all data (31 taxa). Numbers above branches are Bayesian posterior probability and ML bootstrap percentage, shown only if ≥ 0.9 and 70, respectively. Taxon names include specimens' museum accession number or GenBank accession number (in italics) for sequences derived from GenBank. For the two outgroup taxa and one ingroup taxon with 28S and COI sequences derived from different specimens, two numbers are shown (** indicates holotype, * paratype).

on single slide; ♂ abdomen only, Eliwana EWMS0006 FMG2628 21 February 2019, J.S. Cocking, G.B. Pearson, scrape method to 30 m depth (WAM E108516) on single slide.

DIAGNOSIS

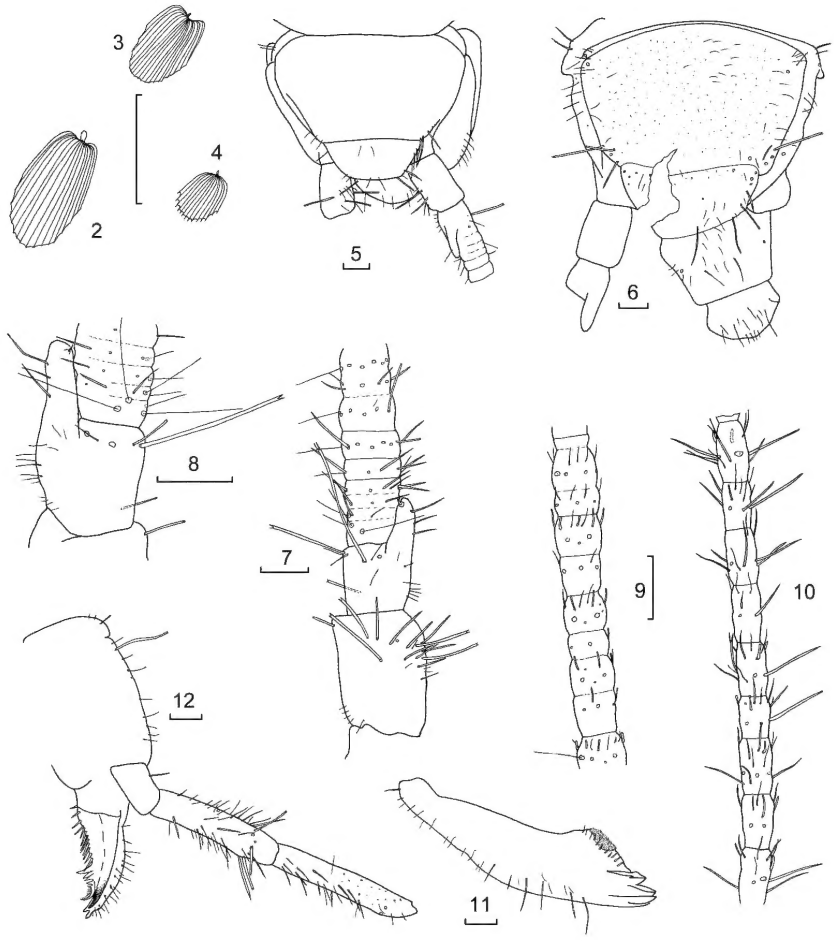
Males of this species, and the closely related *Lepidospora* (*Brinckina*) *relicta* can be distinguished from other species of the subgenus by a combination of characters such as the shape of the apophysis and its terminal spine, the absence of longer setae over the disc of the tergites, the lack of chaetotaxy in the medial region of the posterior margin of the urotergites including urotergite IX, the downward directed posterior processes of urotergite X and their 8–10 + 8–10 pegs, the slightly protruding posterior margin of urosternite VIII which is straight or concave (not convex), by the presence of 2+2 conules on the dorsal face of two of the basal divisions of the median filament and the barbed apical spines of the styli. Males of the new species can be distinguished from *L.* (*B*). *relicta* by their shorter form, the wider parameres (circa five times longer than wide versus 7–10), by the very reduced number of small scattered setulae on the disc of the nota, by the obvious concave region in the middle of the posterior margin of urosternite VIII versus almost straight and the absence of strongly bifurcated macrochaetae on the ventral face of at least the division beyond that with the modified spines on the appendix dorsalis.

DESCRIPTION

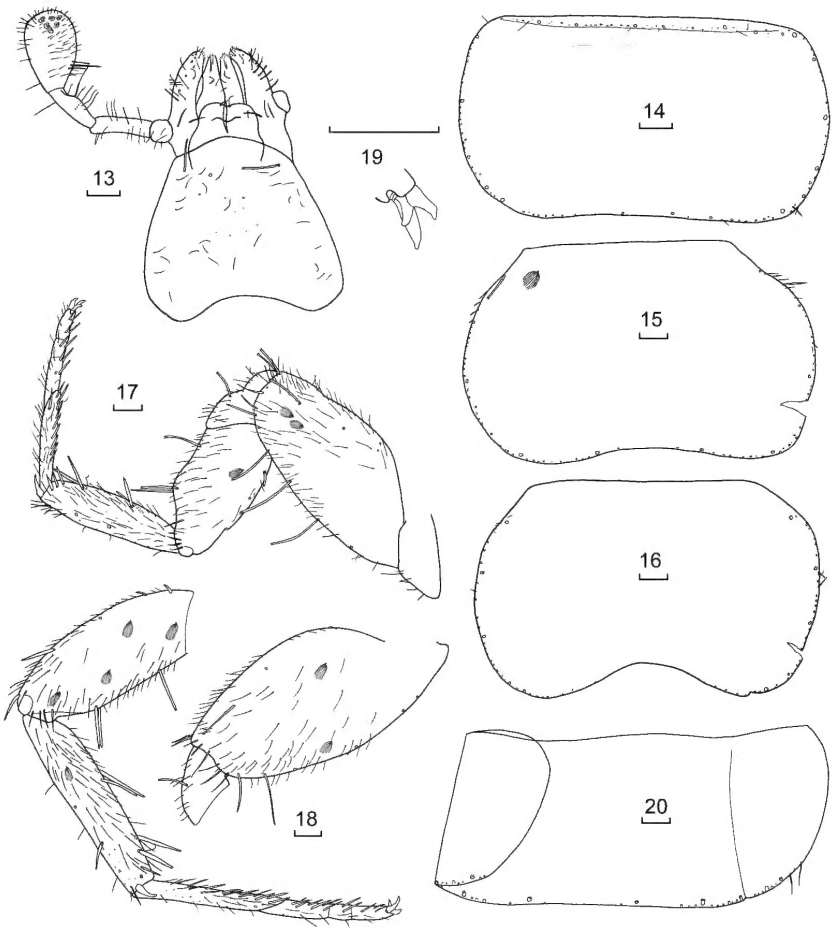
Appearance: Small, parallel-sided silverfish with elongate antennae and terminal filaments i.e. a shape typical for genus but at the shorter and wider end of the spectrum. Appearance when live unknown, probably white in colour, alcohol preserved specimens off-white. Pigment lacking.

Body length: H+B in preserved specimens examined, up to about 5.1 mm (HW 0.83), thorax length up to 1.68 mm or about one third H+B and width 1.05 mm; antennae incomplete in all specimens but at least two thirds H+B; caudal filaments incomplete in all specimens, at least half as long as H+B.

Scales: Multi-radiate with about 15–20 ribs which do not extend significantly beyond the posterior end of the membranes, similar in size and shape on both dorsal (Figure 2) and ventral surfaces (Figure 3), mostly rounded apically, scales covering body but absent from head and its appendages, paramera, cerci and median dorsal appendage and probably the ovipositor (present on subgenital plate). Scales present on both coxa and femora (Figure 4), smaller than those on the body and with the ends of the ribs surpassing the margin of the membrane by about 5% of their length. A single scale is visible on the tibia of PIII of the holotype but no obvious scale insertion points can be seen and it is suspected that



FIGURES 2–12 *Lepidospora (Brinckina) maceveyi* Smith & Mitchell sp. nov., holotype ♂ unless indicated otherwise by specimen number: 2) scale from urotergite IV; 3) scale from urosternite V; 4) scale from femur PIII; 5) head, in alcohol (E108517); 6) head on slide; 7) left scape, pedicel and basal flagellomeres; 8) right pedicel and basal flagellomeres; 9) antennae, interval about half to two-thirds along flagellum; 10) antenna, most distal surviving interval; 11) mandible; 12) maxilla (palp incomplete). Scale bars 0.1 mm.



FIGURES 13–20 *Lepidospora (Brinckina) maceveyi* Smith & Mitchell sp. nov., holotype ♂: 13) labium; 14) pronotum; 15) mesonotum; 16) metanotum; 17) PII; 18) PIII; 19) pretarsus of PII; 20) urotergite V. Scale bars 0.1 mm.

this scale has been dislodged from elsewhere and is just lying on the tibia.

Macrochaetae: Most simple, parallel-sided with distinct apical bifurcations but some on legs are stout and carrot-shaped usually without an apical bifurcation. Some of the longer parallel-sided macrochaetae, when slide mounted, show the same distortion reported in Smith et al. (2012) which is now believed to be an artefact caused by the Tendeiro medium.

Head: Almost as long as wide, not covered by prothorax at hind margin (Figures 5–6), prognathous, vertex with 1+1 macrochaetae in postero-lateral corners as well as some smaller setae; five larger macrochaetae in antero-lateral corners adjacent to the antennal bases and 1+1 setae between the two groups; disc with numerous scattered small fine setae. — Clypeus with transverse row of four setae and two small fine setae between the middle setae. — Labrum with similar transverse row of setae, two of which are longer than the others. — Antennae elongate; scape of ♂ longer than wide, with several strong macrochaetae (Figure 7) both above and below; pedicel of ♂ with large thumb-shaped apophyses on mediad face (Figures 7–8) about three times longer than wide, armed sub-apically with a short conical seta on the dorsal aspect, each apophysis reaching to about the third or fourth interval, but the sutures between the intervals can be difficult to see until the fourth or fifth; four trichobothria on the basal annulus and two each on the following five or six annuli; the eighth interval has two rings setae each with two trichobothria in the most distal ring, further subdivided into four annuli by the eleventh interval, each with a ring

of setae and two trichobothria in the most distal annulus; intervals around mid-antennae (Figure 9) consisting of eight annuli with only a single trichobothrium in the most distal annulus; most annuli also with a ring of fine setae or perhaps basiconic sensilla subapically. The most distal surviving intervals (probably about two-thirds antennae length) also with similar pattern but the arrangement of fine setae and basiconic sensilla distad of the ring of setae more scattered (Figure 10). The nature of these fine setae/sensilla is unclear on slide material, some are typical 'sausage-shaped' type C sensilla (see Adel, 1984) but other appear to be much longer and finer, almost indistinguishable from fine setae except that their ends appear to be rounded. — Mandibles (Figure 11) strong with well-developed molar and incisor regions and one apically bifurcate macrochaeta on the external face as well as a few longer simple setae. — Maxillae (Figure 12) of usual form, galea only surpassing length of lacinia by the two distinct apical papillae, lacinia well sclerotised with one strong apical tooth and a quite strong secondary tooth; pectinate prostheca not much shorter than lacinia with several lamellate processes and about 13 setae along margin; maxillary palp missing beyond third article in all specimens, appears to be fairly long, third article subapically appears to have two stronger setae. — Labium (Figure 13) longer than wide, ultimate article is about 1.3–1.4 times longer than wide with six papillae of usual type; the penultimate article with an oblique ring of longer stronger setae in the distal half.

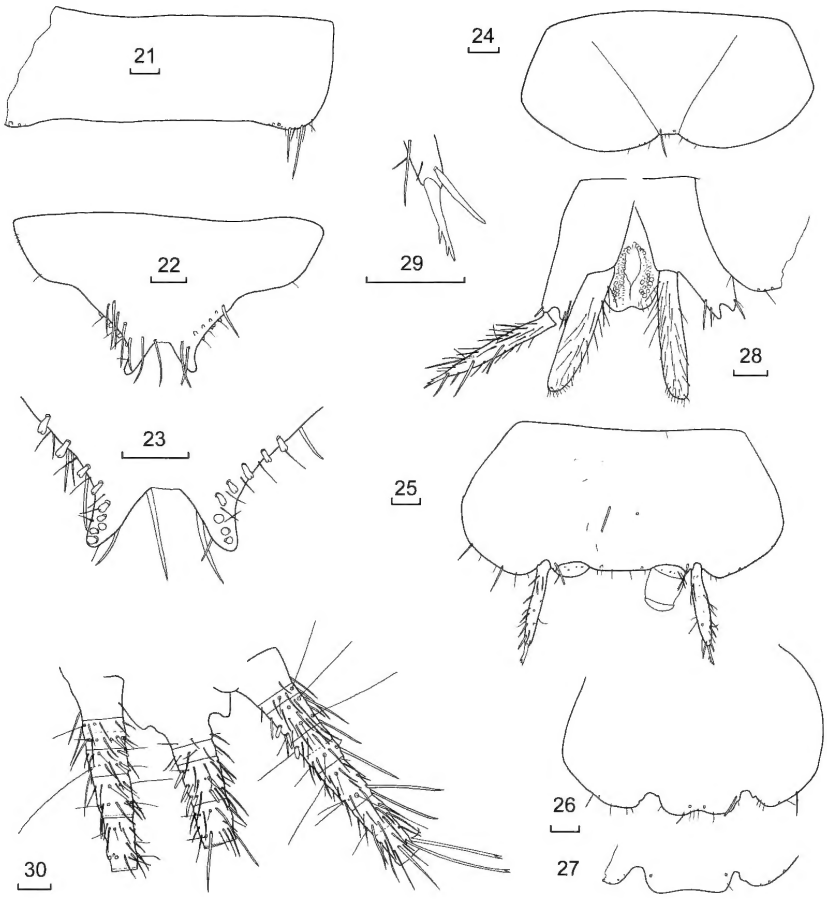
Thorax: About one third H+B and not wider than the abdomen, all nota of similar size; prothorax with obvious collar of six longer macrochaetae and many smaller setae, all nota with five strong submarginal macrochaetae along the lateral and the outer parts of the posterior margins, as well as shorter setae and setulae, the medial part of the posterior margin without macrochaetae; disc of nota with a few scattered setulae (Figures 14–16).

Legs typical for genus, PI missing in all specimens. Tibia L/W ratio of legs, PII 3.3–5.5, PIII 5.3; tarsi L/W ratio PII 8.9–10.8, PIII 14.2. PIII longer than PII. Legs quite elongate (Figures 17–18). Coxae with about five long macrochaetae spaced along the outer margin, with smaller macrochaetae more distally along this margin as illustrated, inner margin with two isolated macrochaetae well removed from the margin, margins and face covered with scattered fine setae and some scales; trochanter with one small macrochaeta and several smaller setae; femur with five stout curved carrot-shaped macrochaetae along leading margin, becoming longer distally, posterior margin with a macrochaeta proximally and two macrochaetae, on the distal bulge; tibia with two stout macrochaetae near the dorsal margin about one half and two thirds the distance along this margin, ventral margin with three tapered macrochaetae about one third along the margin and two longer macrochaetae at about three-quarters along the margin, three smaller, stout macrochaetae in a line near the distal margin, the usual distal spur is fairly short and smooth (without small subapical teeth); tarsus with four articles the basal one being almost as long as the other three together on both PII and PIII, each article with 1–7 paired stout carrot-shaped setae along its ventral surface depending on length of article; pretarsus (Figure 19) with two strong claws and a stout medial empodial claw, all claws in the holotype with unusual rounded apices but those of the paratype E108515 of normal pointed appearance.

Abdomen: Not much narrower than the thorax at its base. All urotergites wrap around the body without a sharp fold laterally. A suture between the tergite and the paratergites visible on II–VIII. Abdominal tergites I–VIII (Figure 20) on each side with three submarginal macrochaetae and one or two larger setae as well as smaller setae and setulae mediad of the suture, the medial region without chaetotaxy, and one submarginal macrochaeta plus two or three larger as well as some smaller setae and setulae laterad of the suture. Urotergite IX with reduced chaetotaxy; each side with one submarginal macrochaeta and two or three large setae as well as some smaller setae and setulae (Figure 21). Discs of all tergites with almost no scattered setulae, just a few on urotergite I and some in the antero-lateral corners of urotergites II–IV.

Urotergite X (Figures 22–23) with rounded posterior emargination, with 7+7 strong pointed submarginal setae on the dorsal surface; ventrally the posterior corners point downwards; each of these extended corners armed with 8–10 pegs as well as a few fine setae.

Urosternite I divided into a median sternum and two lateral coxites (Figure 24), the sternum without setae on the disc, the posterior margin with 1+1 submarginal setae as well as some tiny setulae on the margin; posterior margin of the lateral coxites each with a seta insertion on the margin not far from the suture with the sternum, as well as some setulae. Urosternites II–VII entire (Figure 25), not divided into separate coxites and median sternum, each bearing 1+1 styli and two apically bifurcate macrochaetae in the middle of the disc, and another subposteriorly on each side mediad of the base of each stylus; posterior margin with 1+1 macrochaetae and some setulae, the margins laterad of the styli with a few setae and setulae. Eversible vesicles each with about four or five setae on the vesicle as well as a few setulae, on urosternites II–VI; VII with pseudovesicles. Urosternite VIII (Figures 26–27) also entire, without vesicles, with 1+1 macrochaetae mediad of each stylus base (absent on right side of holotype), posterior margin slightly protruding with distinct concave region in the middle which also has 1+1 submarginal macrochaetae as well as about six small marginal setulae (this concavity is quite abrupt in the holotype and paratype E108516 but more broad in paratype E108517), margins laterad of the styli with some small setulae and one or two small setae. Apical spine of the few styli still present all with two or three barbs (Figure 29).



FIGURES 21–30 *Lepidospora (Brinckina) maceveyi* Smith & Mitchell sp. nov., holotype ♂ unless indicated otherwise by specimen number: 21) urotergite IX; 22) urotergite X, from above; 23) urotergite X, from below; 24) urosternite I; 25) urosternite III; 26) urosternite VIII; 27) urosternite VIII of paratype ♂ (E108517); 28) coxites IX, penis and parameres; 29) terminal spines of stylus IX; 30) base of terminal filaments, from below. Scale bars 0.1 mm.

Urosternite IX (Figure 28) divided into separate coxites bearing styli and long parameres (L/W 4.7–5.0). Parameres reach to about one half the length of the styli, with several setae along their length and some small apical setulae. External process of coxites with one small seta and a setula; internal process with two setae near the inner margin. — Penis with longitudinal opening lined with hairs or lamellae, some glands visible basally.

Appendix dorsalis of ♂ (Figure 30) without pegs on short basal division, dorsally with 2+3 clearly modified spines (i.e. short, stout and with either a rounded or acute apex) on the longer third division, the following division without modified spines, each ring of setae or macrochaetae associated with short trichobothria, the ventral macrochaetae simple, not apically bifurcate, at least in the four divisions still intact; basal division of cerci (Figure 30) without modified chaetotaxy, following division with two rings of setae and trichobothria, each ring with a modified peg on the medial face of which the basal one has a sharp point, the distad is rounded, third division also with two rings of chaetotaxy with a rounded peg on the medial face of both rings, fourth division without modified chaetotaxy although the more basal macrochaeta, analogous to the peg, is somewhat thickened basally, the following division beginning to divide into two sections each with two rings of setae, the most distal ring in this division with stronger macrochaetae, those on the outer margin with strong bifurcations apically.

Female

As for male except pedicel without apophyses (Figure 31); urotergite X trapezoidal with 1+1 macrochaetae in the postero-lateral corners, medial indentation not wide (Figure 32), without pegs on ventral surface; terminal filaments presumably also without pegs. Coxites VIII and IX separated, subgenital plate rounded subtriangular with small submarginal setae distally and setulae scattered along the outer margins (Figure 33). Ovipositor with about 13 divisions, very slightly spindle-shaped (i.e. wider in the mid region) and not particularly long, only surpassing the apices of styli IX by a few divisions. The apex of the anterior valves with a typical acute triangular projection, that of the posterior valves rounded with the typical region of hooked processes on the penultimate division; both with simple fine setae only.

HABITAT

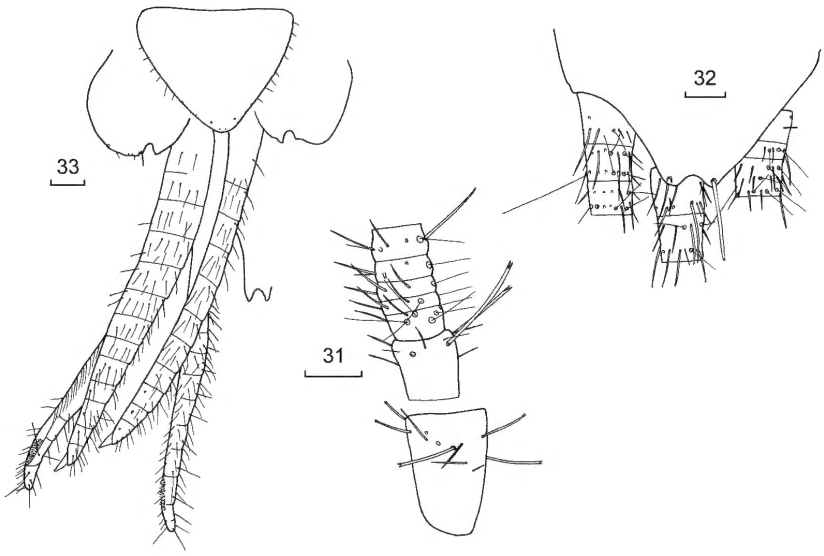
All material examined was collected from two uncased mining exploration drill holes in the Hamersley Range. This range consists of an extensive series of connected rugged hills that run approximately 400 km across the Pilbara region of north-western Australia. The geology of the area is dominated by various iron formations, with the drill holes yielding *Lepidospora (Brinckina) maceveyi* occurring in banded iron formation. When weathered this formation develops vugs and voids that provide habitat for troglofauna. The exact depth from which the animals were collected is unknown because they were collected from the walls of the drill holes with a net.

Other troglobitic species collected from the type locality EW0103 included *Draculoides* schizomids, *Nocticola* cockroaches, *Prethopalpus* oonopids and *Cryptops* centipedes. A large root mat occurring in the hole contained cockroaches and schizomids but no *Lepidospora*. Other troglobitic species at the paratype locality EWMS0006 were *Ptinella* beetles, *Hanseniella* symphylans and a centipede of the family Ballophilidae.

Mean annual rainfall at Paraburdoo airport 125 km to the south east of the type locality is 277 mm, with 88% of the rain falling between January and June. The mean annual maximum temperature is 33.7° C, with a mean monthly maximum temperature of 40.7° C in January. Despite the arid climate, data from elsewhere in the Pilbara suggest relative humidity below ground is maintained at close to 100% (Halse 2018).

ETYMOLOGY

The species is named for Dr Shane McEvey of the Australian Museum, who has provided much guidance to the second author and convinced him to develop a data base with a unique specimen number for each specimen collected. This data base has become central to our work on the Zygentoma and made so many other activities more efficient and traceable.



FIGURES 31–33 *Lepidospora (Brinckina) maceveyi* Smith & Mitchell sp. nov., paratype ♀ (E108515): 31) antenna, scape, pedicel and basal annuli; 32) urotergite X, from above; 33) subgenital plate, coxites IX and ovipositor. All scale bars 0.1 mm.

DISCUSSION

Morphologically the new species appears to be close to the other only other described Australian species of the Coletiniinae *Lepidospora (Brinckina) relicta* Smith & McRae 2016, with both having an absence of larger setae over the disc of the nota, a medial region of all tergites lacking chaetotaxy and the presence of conules on the basal divisions of the median dorsal appendage. It does not appear to be as elongated as *L. (B.) relicta* although clearly would qualify as a troglobite based on its only known habitat.

The species will key to *L. (B.) relicta* using the key of Mendes (2002) combined with the emendation of Smith & McRae (2016) but the species can easily be distinguished by the obvious concave region in the middle of the posterior margin of urosternite VIII of the males of the new species versus almost straight for *L. (B.) relicta*.

When describing *L. (B.) relicta*, scales were reported only on the coxae. The new species has scales on the femora as well as the coxae. Looking at the illustrations in Smith & McRae (2016), it appears that there may be a small area of the femora without setae (smaller than in the new species) and it would probably be worth re-checking for scales in *L. (B.) relicta* before considering this to be a useful character to separate the species.

CONCLUSION

Molecular data confirm the close relationship between the Atelurinae and Coletiniinae, however there is relatively weak support for relationships among Atelurini, Atopatelurini and Coletiniinae. More genetic data is needed, and more taxa need to be sampled to get a firmer grasp of relationships.

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Are these the world's most colourful silverfish? Possible mutillid mimics from Western Australia (Zygentoma: Lepismatidae)

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ABSTRACT – Citizen scientists in Western Australia photographed silverfish with very striking colour patterns, resembling velvet ants. When collected and placed into alcohol these colour patterns disappear, possibly accounting for the previous lack of observations of such colours in Zygentoma. The specimens were found to belong to the genus *Hemitelsella* Smith. Two new species are described, *H. hortorum* sp. nov. and *H. mutilloides* sp. nov., and molecular data (28S and COI) presented for these as well as *H. transpectinata* (Smith) from Barrow Island and *H. clarksonorum* Smith from Tasmania.

KEYWORDS: Thysanura, taxonomy, new species, Batesian mimicry, Mutillidae

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INTRODUCTION

Even though more species of silverfish have been described from Australia than from any other country, the fauna is still very poorly known and many species lie undescribed in museum collections (Smith 2017). Faunal surprises were to be expected given the inadequate level of study but the species described here would have to be the most colourful silverfish so far reported worldwide and the first documented example of Batesian mimicry in the Zygentoma. Most commonly encountered silverfish species are very similar in appearance, being overall grey in colour and hence arousing little interest among non-specialists. Silverfish, like moths and butterflies, are covered in scales and it is perhaps surprising that differences in their scale patterns generally do not approach the patterns and colours seen in the Lepidoptera. Perhaps this is due to their cryptic behaviour where they generally hide in the dark, so colour patterns may be of little use.

Unfortunately, silverfish lose many of their scales between moults through normal activity but also during collection and handling. Any coloured scale pattern remaining becomes very difficult to distinguish once the species is placed into alcohol and virtually impossible to interpret when mounted onto slides. More often than not, species are described, never having been seen live by the describer. Scale pattern is rarely mentioned in most descriptions. Two species of the genus *Hemitelsella* Smith were recently described from alcohol preserved material collected on Barrow Island and near Launceston in Tasmania (Smith 2015, 2016). Even in alcohol, these species showed strong differences in the pattern of lighter and darker scales which the first author attempted to capture in his illustrations, although it now seems with only minimal success.

In October, 2018 Jean and Fred Hort photographed a large silverfish in south-western Western Australia which displayed a very remarkable pattern of reddish-brown, black and white scales. The image was posted on-line and found by the first author who contacted the Horts. They kindly collected three more specimens from the Wallaby Hills Nature Reserve, Malebelling, and another from Flynn. It was quickly confirmed that these silverfish also belong to the genus *Hemitelsella* and molecular data suggested there were two separate species.

On seeing these images, the second author commented that the scale pattern reminded him of the pattern on some velvet ants (Hymenoptera: Mutillidae) and suggested the silverfish may be mimicking these wasps as a means of discouraging predators. Velvet ants are known for their painful stings and Batesian mimicry of velvet ants has been recorded in several groups such as beetles (e.g. Acorn, 1988, Mawdsley, 1994, Lanteri, 2005), lacewing larvae (Brach, 1978) and spiders (e.g. Nentwig, 1985). We circulated an image of

one species to entomologists familiar with Mutillidae (Graham Brown at the Northern Territory Museum and Art Gallery, Kevin Williams at the California Department of Food and Agriculture, Juanita Rodriguez and Madalene Giannotta both at the Australian National Insect Collection) for their valued opinion as to whether these silverfish were likely to be mimicking velvet ants and all agreed they did.

We also present here molecular data for two genes (28S and COI) for both new species of *Hemitelsella* as well as for *Hemitelsella transpectinata* (Smith, 2015) and *H. clarksonorum* Smith, 2016, finding much smaller molecular distances between morphologically distinct species than that reported in Smith et al. (2019) for silverfish of the subfamily Heterolepismatinae. It is a pity that no photos exist of live specimens of the Barrow Island or Tasmanian *Hemitelsella* species as it is possible that all species of this genus could display striking scale patterns.

SPECIMEN COLLECTION AND PREPARATION METHODS

The holotype of both species and the allotype of one are deposited in the entomological collection of the Western Australian Museum in Perth. One paratype is retained in the Australian Museum collection as indicated in the material examined for each species.

Specimens are stored in 75–80% ethanol unless noted as slide mounted. Shortly after collection, a leg was removed from some specimens and placed in 100% ethanol and stored at 4°C for DNA sequencing.

Measurement data of whole specimens in alcohol and dissection methods used are as described in Smith (2013). Specimens were dissected and each mounted on two slides using Tendeiro medium (Molero-Baltanás et al., 2000), with the head and thorax mounted on one slide and the abdomen on a second slide. Roman numerals are used to indicate abdominal segment number. The following abbreviations are also used: AMS: Australian Museum, Sydney; HW: head width (in millimetres); H+B: head and body length (in millimetres); L/W: length to width (ratio); PI, PII, PIII: legs of pro-, meso- and metathorax respectively; WA: Western Australia. The term *macrochaetae* refers to the larger stronger pectinate bristles, *setae* refers to smaller thinner bristles (usually simple), *setulae* to the very small, usually straight setae and *cilia* to the curly thin hairs, often associated with the combs, setal collar or notal margins. In most cases, these cilia are sensilla trichodea (sensu Adel, 1984).

SAMPLING, DNA EXTRACTION, PCR EXTRACTION, PCR AND DNA SEQUENCING

DNA extractions were performed using the Bioline Isolate II Genomic DNA Kit (Bioline, Eveleigh, NSW) following the manufacturer's protocol with elution volume adjusted to 70 µL. Tissue samples (a single leg from each specimen) were soaked in DNA extraction buffer containing proteinase-K at 50°C for one hour.

Polymerase Chain Reaction (PCR) amplification of the DNA barcode region of the mitochondrial COI gene used the primers and followed the method of Mitchell (2015). For the 28S rDNA D9–D10 region, we used primers 28S_8fm and 28S_11rm, which are 5'-M13-tailed versions of Machida and Knowlton's (2012) primers [28S] #8 and [28S] #11_RC, respectively. PCR conditions for both genes followed those reported in Mitchell (2015) for COI. PCR products were purified using ExoSAP and sequenced in both directions using ABI Big Dye Terminator v.3.1 chemistry by Macrogen Inc. (Seoul, South Korea).

DNA SEQUENCE ASSEMBLY AND PHYLOGENETIC ANALYSIS

Forward and reverse direction sequence trace files were assembled using Geneious v.10.2.6 (Kearse et al., 2012). DNA consensus sequences, sequence trace files, and specimen collection data were uploaded to BOLD (Ratnasingham & Hebert, 2007) where they are accessible as public dataset DS-HEMIMUT (dx.doi.org/10.5883/DS-HEMIMUT). Sequences newly derived for this study were also deposited in GenBank (accession numbers MZ364329–364342). Table 1 lists the museum, BOLD and GenBank accession numbers. The outgroup, *Ctenolepisma longicaudatum*, was selected from the authors' previously published studies (Smith et al., 2019).

Consensus sequences were aligned by eye. Three data sets were constructed: 28S (10 sequences), COI (11 sequences), and combined data (11 concatenated sequences).

MEGA X v. 10.0.5 (Kumar et al., 2018) was used to calculate uncorrected distances (p-distances) between sequences and to select the most appropriate models for phylogenetic analysis, based on the Akaike Information Criterion, Corrected (AICc).

Phylogenetic analyses were performed by Bayesian Inference (BI) using MrBayes 3.2.6 (Ronquist et al., 2003) and under Maximum Likelihood (ML) using RAxML v8.2.10 (Stamatakis, 2014), both packages being run within Geneious. The BI analyses were set to run for 2 million generations, with a sample frequency of 1,000, using 2 runs, setting the number of chains to 4, and the burnin to 500 samples (i.e., the recommended 25% of samples). The average standard deviation of split frequencies was observed to drop below 0.01 after each analysis, indicating convergence of the chains. ML analysis used the hill climbing algorithm with 1,000 rapid bootstrap replicates. All trees were rooted with *Ctenolepisma longicaudatum*.

TABLE 1 Museum, BOLD and GenBank accession numbers for all new sequences obtained.

Species	Voucher Type	Sample ID	Museum Accession	COI GenBank Accession	28S GenBank Accession	Collection Date	Locality
Ctenolepisma longicaudatum		gbs001836	K377675	MT674899	MK185707	18 August 2011	TAS, Hobart
Qantelsella louisae	Holotype	gbs003917	T228755	MK185705	MK185709	17 February 2016	QLD, Bladensburg NP
Acrotelsella parvelar	Holotype	gbs004624	K261103	MT674895	MK185706	23 April 2015	TAS, Travellers Rest
Acrotelsella ernei	Paratype	gbs001438	K377609	MK185701		10 July 2009	NT, West MacDonnell NP
Hemitelsella clarksonorum	Holotype	gbs004625	K261105	MZ364329	MZ364336	14 April 2015	TAS, Travellers Rest
Hemitelsella transpectinata	Topotypic	gbs006167	K261328	MZ364330	MZ364337	2016	WA, Barrow Island
Hemitelsella transpectinata	Topotypic	gbs006166	K541612	MZ364332	MZ364339	2016	WA, Barrow Island
Hemitelsella hortorum sp. nov.	Holotype	gbs006161	E109767	MZ364331	MZ364338	17 October 2020	WA, Flynn
Hemitelsella mutilloides sp. nov.	Holotype	gbs006162	E109768	MZ364334	MZ364341	14 October 2020	WA, Malebelling
Hemitelsella mutilloides sp. nov.	Paratype	gbs006163	E109769	MZ364335	MZ364342	14 October 2020	WA, Malebelling
Hemitelsella mutilloides sp. nov.	Paratype	gbs006164	K377941	MZ364333	MZ364340	14 October 2020	WA, Malebelling

RESULTS

MOLECULAR DATA

Figure 1 shows the Bayesian tree for the combined data set. There is strong support (Bayesian posterior probability ≥ 0.9 and ML bootstrap percentage ≥ 70) for the monophyly of *Hemitelsella*, for the sister-group relationship between *H. clarksonorum* and *H. transpectinata*, a sister-group relationship between the two new species, and for the monophyly of the two species which were represented by multiple samples. The same tree structure was observed for COI data alone (Figure 2), except that support for the monophyly of *Hemitelsella* was weak. The 28S tree (Figure 3) showed strong support for the monophyly of *Hemitelsella* but less support for relationships among species, with *H. clarksonorum* and *H. transpectinata* having identical 28S sequences. The maximum difference found was 1.35% between *H. mutilloides* and *H. clarksonorum*.

Within *Hemitelsella*, COI distances among species ranged from a minimum of 5.18% between *H. clarksonorum* and *H. transpectinata* to a mean of 8.47% between the two new species, to a maximum of 13.99% between *H. mutilloides* and *H. clarksonorum*.

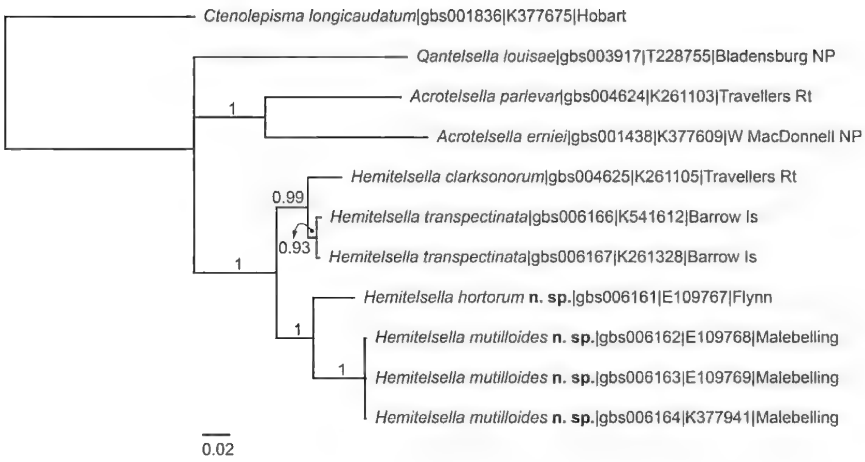


FIGURE 1 BI tree for concatenated COI and 28S genes with BI posterior probabilities shown above the branches.

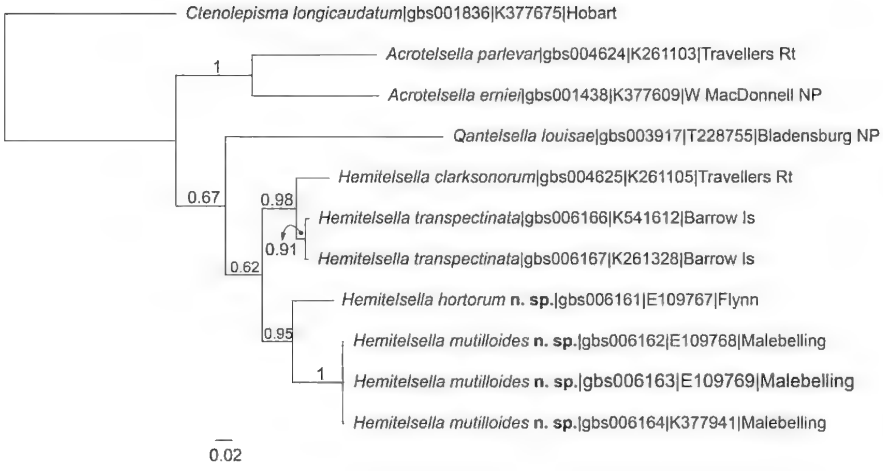


FIGURE 2 BI tree for COI gene with BI posterior probabilities shown above the branches.

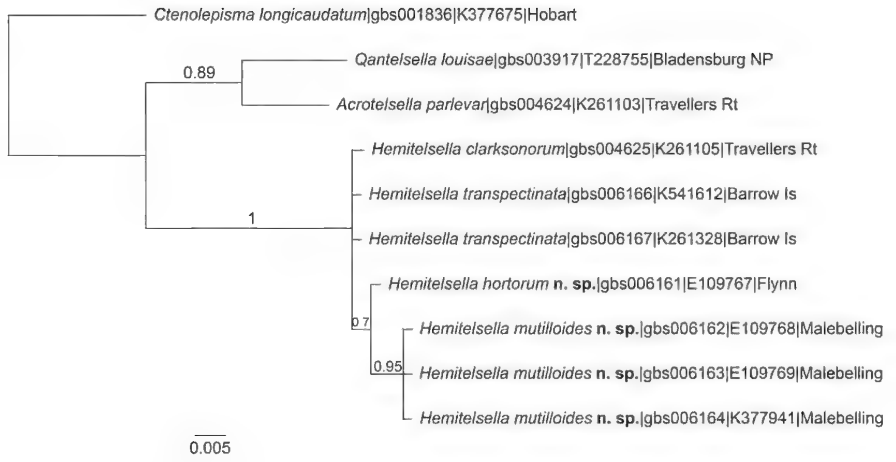


FIGURE 3 BI tree for 28S gene with BI posterior probabilities shown above the branches.

SYSTEMATICS

Family Lepismatidae Latreille, 1802

Subfamily Ctenolepismatinae Mendes, 1991

Ctenolepismatinae Mendes, 1991: 11.

Hemitelsella Smith, 2016

Hemitelsella Smith, 2016: 72.

TYPE SPECIES

Acrotelsella transpectinata Smith, 2015, by original designation.

Hemitelsella mutilloides sp. nov.

Figures 4, 8–36

urn:lsid:zoobank.org:act:8FD44026-93A4-464F-95F3-38B4F078C825

MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♀ (HW 1.13), Malebelling, Wallaby Hills Nature Reserve (31.8459°S 116.9859°E), 14 October 2020, Jean and Fred Hort, hand collected on yellow sandy clay soil (WAM E109768) on two slides.

Paratypes

Australia: ***Western Australia:*** ♂ (HW 0.88), same data as holotype (WAM E109769) on two slides; ♀ (HW 1.08), same data as holotype (AMS K.377941) in alcohol.

DIAGNOSIS

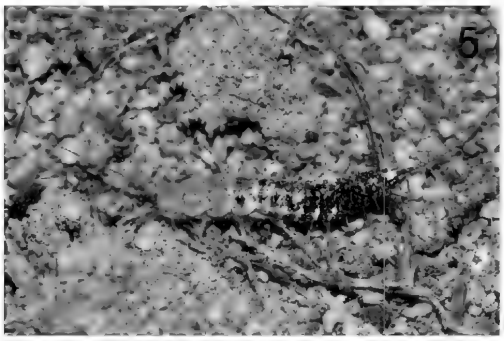
This species can be distinguished from *Hemitelsella transpectinata* (Smith) by its striking colour pattern when live (as well as other characters (see Table 4), but this pattern may be similar to that of *H. clarksonorum* and *H. hortorum*. It can be distinguished from *H. clarksonorum* by the shorter length of the more posterior of the 3+3 combs of the prothoracic sternum versus 3+3 of subequal length as well as the reduced number of labial palp papillae (six versus 8–9) and from *H. hortorum* by the rounded inner corner of coxites VIII (versus almost square) and the larger number of modified spines on the apex of the apical division of the ovipositor (6–9 versus 3–4).

DESCRIPTION

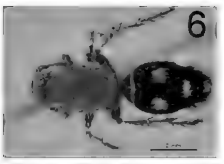
Appearance: medium sized silverfish, with narrow body, thorax not much wider than abdomen which only tapers slightly posteriorly from about the fifth abdominal segment. Appearance when live quite dramatic (Figure 4) resembling a velvet ant (Mutillidae) (Figures 6–7) with anterior third even reddish brown and posterior two thirds black with white patches on the lateral sides of the anterior six abdominal segments as well as medially on the anterior three or four urotergites, urotergite X also with white medial patch, styli IX white, terminal filaments black; legs reddish brown. In alcohol, head uniformly covered with reddish-brown scales, without wide areas of hyaline scales along the sides and front of the head; pro and meso nota also fairly evenly covered in reddish-brown scales, metanotum and urotergite I with darker scales submedially but lighter scales medially and at outer margin, urotergites I–III also with darker scales along margins, these darker scales surround distinct circular light patches on IV–VI but these patches absent on urotergites VII–IX; eyes dark grey. Terminal

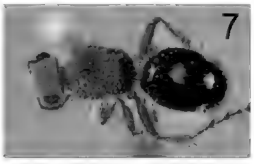
filaments very dark due to brown pigment and black scales.

Body length: 7.85 mm (♀); head width 1.13 mm; thorax: length 2.35 mm or 0.33 times H+B; width up to 1.48 mm with no great difference between the pro, meso and metanota although the metanotum is the widest and the pronotum the narrowest, pronotum slightly shorter than meso or metanota; antenna complete (?) 6.0 mm or 0.85 times H+B; terminal filaments all incomplete, maximum length of cercus remaining 5.0 mm or 0.7 H+B; maximum length of median dorsal appendage remaining 3.0 mm or 0.42 H+B.



FIGURES 4–5 *Hemitelsella* species: 4) *Hemitelsella mutilloides* sp. nov.; 5) *Hemitelsella hortorum* sp. nov. (photos courtesy Fred and Jean Hort).





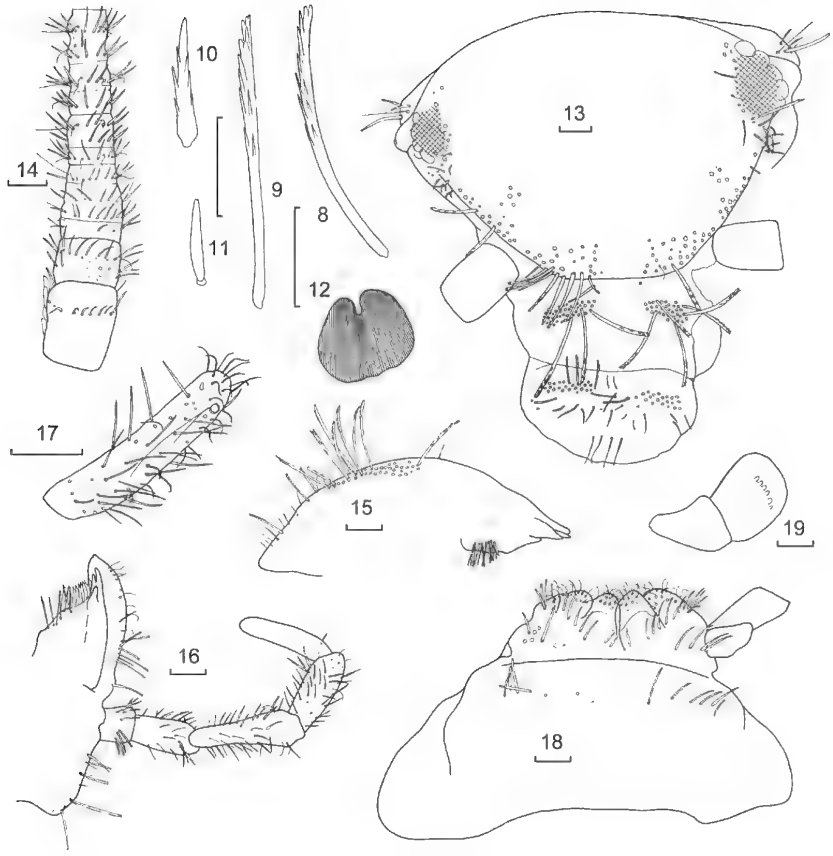
FIGURES 6–7 Possible velvet ant models for mimicry: 6) *Ephutomorpha* cf. *pacificatrix*; 7) *Ephutomorpha* sp. (photos courtesy K. Williams).

Pigmentation: frons, clypeus, labrum and scape without obvious pigment, pedicel slightly darker, the intervals of the flagellum becoming increasingly darker distally. Mandibles, maxillae, labium and its palp unpigmented, maxillary palp with light reddish-brown pigment on distal two articles. Legs with light to medium reddish-brown pigment overall, becoming stronger in more distal articles. Nota without obvious pigment but cuticle closer to lateral margins of more granular appearance, urotergites and urosternites I–VIII appear to be unpigmented, urotergite X with even light brown pigment. Coxites IX of female with brown blotchy pigment. Penis with light pigment overall, styli without pigment, cerci and median filament reddish-brown, darker distally with the basal two annuli of each division lighter than the others in the allotype but not so in the holotype. Ovipositor with distinctly orange pigmented anterior gonapophyses with sutures even darker than the surface, posterior gonapophyses lightly brown pigment.

Macrochaetae: pectinate and of variable form (Figures 8–10), mostly light to quite dark brown, but hyaline or straw coloured in some cases. The macrochaetae along the edges of the nota do not have bifurcated apices and only very subtle pectinations along the shaft and quite different to the submarginal macrochaetae which are obviously pectinate especially apically. The larger setae of the tarsi are strongly sclerotised and have rounded tips (Figure 11).

Scales: with numerous subparallel ribs that do not surpass the margin of the scale; ribs mostly close together or even very close together in the darker scales but a rare few scales observed where the ribs are a little further apart (Figure 12), these ribs are often diverging from each other distally giving an open fan appearance rather than being almost parallel; shape of scales generally round, although the posterior margin can be quite straight for those scales overhanging the posterior margins of the tergites and others are shaped to fit around setae or combs. Scales found on top of head, on clypeus, scape, all nota, all thoracic sterna, legs but absent from trochanter and tarsi (except probably the basal article of the tarsus of PIII), present on all urotergites and urosternites, styli and on the terminal filaments, even the more distal divisions. Scales of the terminal filaments very diverse in shape including some very broad as well as lanceolate scales.

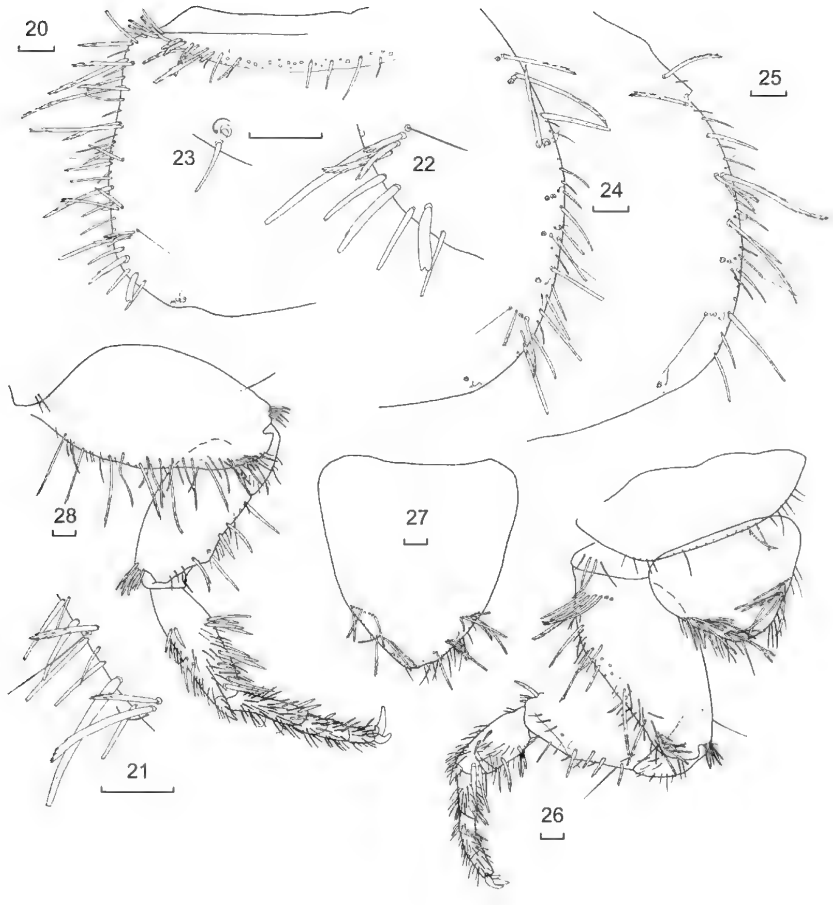
Head: wider than long (Figure 13), with 1+1 weak bushes of pectinate macrochaetae on the antero-lateral corners, not very dense and only weakly aligned in distinct rows. A small gap in the chaetotaxy of only 1–2 macrochaetae wide along the margin above the antennae and the macrochaetae continue along the margin only one or perhaps two macrochaetae wide to the level of the eyes and then running above the eyes and beyond the eyes. The 1+1 peri-antennal groups a little isolated from marginal rows consist of only 4–5 macrochaetae perhaps also with a cilium or long thin setae (lost in all specimens); 1+1 isolated single



FIGURES 8–19 *Hemitelsella mutilloides* sp. nov. holotype ♀ (E109768): 8) pectinate macrochaeta of clypeus; 9) pectinate macrochaetae of coxa of PI; 10) carrot-shaped pectinate macrochaeta from femur of PI; 11) strong apically rounded seta of tarsus or PI; 12) darker scale of pronotum; 13) head (cross-hatched area obscured by eye pigment, graphically reconstructed to re-join left eye region to remainder of head; 14) antenna, scape, pedicel and basal articles of flagellum; 15) mandible; 16) maxilla, smaller setae of last article omitted; 17) idem, ultimate article of palp; 18) labium, prementum and mentum, palps not connected; 19) ultimate and penultimate articles of labial palp, setae not shown. Scale bars 0.1 mm.

cilia are found anterior to and mediad to these groups. Eyes not well visible on slide material but with each ommatidium somewhat isolated from the adjacent. Clypeus with 1+1 bushes of about 30–40 macrochaetae slightly separated from smaller (2–3 macrochaetae) more lateral groups (very difficult to observe on slides), 1+1 setae between the larger bushes close to the dorsal margin. Labrum also with 1+1 bushes of about 20–30 smaller pectinate macrochaetae as well as a few setae between these groups and two transverse lines of smaller setae, one about midway along the labrum which may be of only four simple setae (in the allotype) or a longer irregular line extending across the labrum, the other located three quarters behind the anterior end of the labrum. — Scape of antenna (Figure 14) not very long, with scales over surface and short robust simple subapical setae, pedicel with a subapical ring of stout setae and another incomplete ring about midway along the pedicel, first annulus (interval) of flagellum with a partial ring of setae, intervals two to five of flagellum each of a single annulus with a single ring of setae, cilia and at least two trichobothria, interval six with second incomplete ring of stout setae only, interval eight with two complete rings of setae and cilia, the trichobothrium only present in the most distal ring, seventh interval with two complete rings, the eight interval with a third ring developing between the other two, ninth interval with four complete rings with the cilia in the most distal and second rings, the trichobothria restricted to the most distal ring; intervals beyond 13th are lost; there may be a circular sensillum on the basal ring but no other specialised sensilla seen on the short preserved section.

— Mandibles (Figure 15) typical for Ctenolepismatinae; a group of about 12 strong and short or thin and longer, apically bifurcated setae distally adjacent to the molar area and a bush of about 40 macrochaetae externally. — Maxilla (Figure 16) with 2–6 thick apically bifurcate macrochaetae and some small simple setae externally proximal to the palp, the lacinia with three strong teeth, one set further back than the other two, followed by about 6–7 lamellate processes and a row of 6–7 thin simple setae, galea with several strong, smooth, pointed setae externally in its basal half and a few cilia distally; apical article of maxillary palp (Figure 17) 3.7–3.9 times longer than wide and only slightly longer than the penultimate article, the ultimate article with a poculiform sensilla near the apex, rod-like basiconic sensilla were not seen, last three articles of palp with simple setae only although some thicker than others, two basal articles with subapical rings of slightly thicker setae. — Labium (Figure 18) wider than long, prementum with an interrupted transverse row of smooth strong setae, glossae and paraglossae with lateral and oblique groups of strong apically bifurcated setae and with short curved setulae distally; labial palp with oval/subrectangular apical article, not greatly widened medially (Figure 19), 1.03–1.07 times longer than wide with row of probably six papillae arranged in a single curved row (very difficult to see in mounted material and only one ultimate article present on K.377941, still in alcohol), other sensilla not observed but possibly present, covered with numerous fine short, sometimes pigmented, setae as well as longer fine setae on along the distal end; penultimate article as long as the ultimate article.



FIGURES 20–28 *Hemitelsella mutilloides* sp. nov. holotype ♀ (E109768) unless otherwise indicated by specimen number: 20) pronotum, left half; 21) idem, left anterior trichobothrial area; 22) idem, left posterior trichobothrial area; 23) idem, left posterior comb of E109769; 24) mesonotum, right side; 25) metanotum, right side; 26) presternum, prothoracic sternum and PI; 27) mesothoracic sternum; 28) PII. All scale bars 0.1 mm.

Thorax: pronotum (Figure 20) with narrow setal collar about two macrochaetae wide and some setae with rare cilia; lateral margins with many strong smooth or subtly pectinate carrot-shaped macrochaetae along the margins as well as some submarginal setae and a few cilia, with 6–7 submarginal combs of 1–2 strongly pectinate macrochaetae, the anterior trichobothrial area about 0.45 along the margin associated with comb N-2 (terminology of Molero-Baltanás, 2010) the trichobothrium located between the mediad strongly pectinate macrochaeta and a strong smooth marginal macrochaeta (Figure 21), the posterior trichobothrium located at the mediad end of a comb of 2–3 pectinate macrochaetae located about 0.70 distance along the margin (Figure 22). Posterior margin with 1+1 single macrochaetae each associated with a marginal seta and a cilium (Figure 23), the posterior combs being positioned quite laterally and almost contiguous with the chaetotaxy of the lateral margin. — Mesonotum (Figure 24) with lateral chaetotaxy similar to pronotum with 5–7 combs of one to three pectinate macrochaetae, the anterior trichobothrial area located about 0.6 along the lateral margin, associated with comb N-2 of just one macrochaeta with the trichobothria located between the macrochaeta and the margin and with a cilium between the trichobothrium and the seta on the margin. Posterior trichobothrial area 0.75 along margin, the trichobothrium located mediad to a group of 2–3 macrochaetae (=N) arranged in a line not in a triangle, (which was an unusual arrangement reported in the description of for the single known specimen of *H. clarksonorum*). Posterior margin with quite laterad 1+1 combs each of a single macrochaeta with a cilium at the outer end and a marginal seta. — Metanotum (Figure 25) similar to mesonotum but with only six combs of 1–2 macrochaetae, the anterior trichobothrial area associated with the comb (N-1) with the trichobothrium located between the single macrochaeta and the margin about 0.74 along the margin, the posterior trichobothrial area associated with the most posterior comb (N) of a single macrochaeta about 0.84 along the margin and the posterior 1+1 combs again quite laterad with a single macrochaeta and a laterad cilium.

Presternum fairly wide, with transverse row of pectinate macrochaetae and smooth setae (Figure 26). All thoracic sterna with hyaline scales. — Prothoracic sternum (Figures 26) short, wider at base than long, (L/W 0.70–0.75) subtriangular but broadly rounded posteriorly, antero-lateral corners without fringe of setae, posterior two thirds of lateral margins with long simple setae as well as 2–3+2–4 irregular combs of 4–6, 3–9, 0–5 and 0–1 pectinate macrochaetae (anterior to posterior) running at an angle of about 20–40° to the margin. — Mesosternum (Figure 27) about as wide as long (L/W 0.98–1.01) and 1.6–1.8 times as long as the prosternum, with long, thin simple marginal setae and a few cilia around the distal third of the margin, 3+3 combs in its distal third, with 4–9, 3–5 and 1–2 pectinate macrochaetae per comb (anterior to posterior). — Metasternum (Figure 29) apically slightly pointed, about 1.2 times wider than long (L/W 0.88) with long marginal setae and cilia along distal one third of lateral margins and (2–3)+(2–3) combs of longer and shorter pectinate macrochaetae, the more proximal with seven macrochaetae the more distal with 0–2.

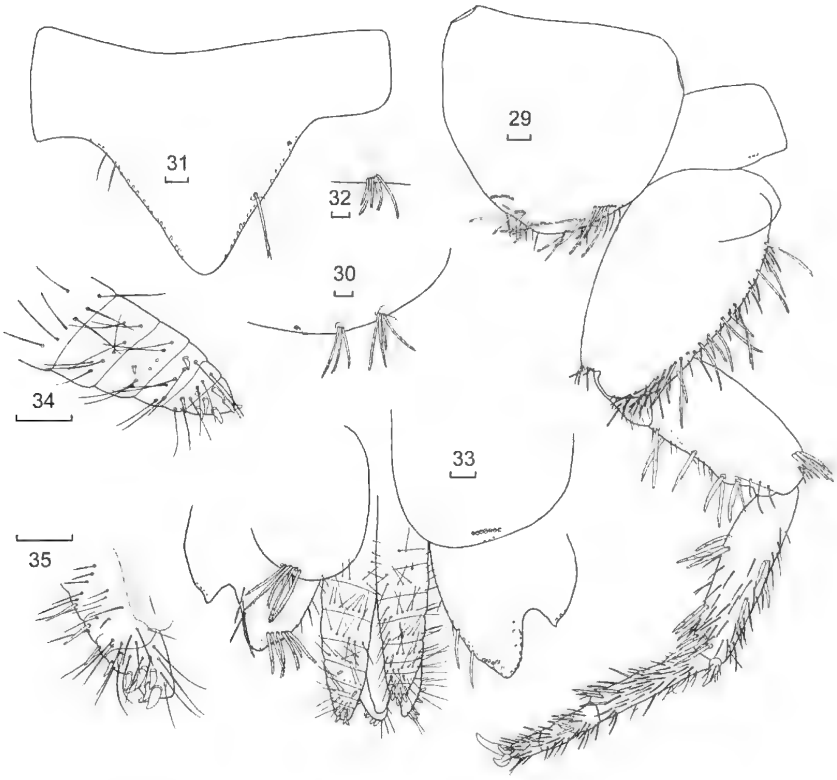
Legs (Figures 26, 28, 29) becoming progressively longer and more slender, tibia L/W ratio of legs PI 2.2–2.6, PII 3.1–3.5, PIII 4.0; tarsi L/W ratio PI 5.3–6.7, PII 7.2–8.1, PIII 9.9–10.3. PI (Figure 26) with comb of four macrochaetae laterally on precoxa. Coxa with scales and a comb of about six macrochaetae on the anterolateral corners followed by scattered strong pectinate macrochaetae along the external margin, never grouped into combs of two macrochaetae, the more marginal macrochaetae being much less pectinate, curved and tapering; inner margin without a macrochaeta on the margin and two long thin setae on the dorsal face and about six setae of varying thickness distally over the articulation. Trochanter with several stout curved setae and one small pectinate seta. Femur ventrally with four strong, thick pectinate tapering macrochaetae between the trochanter and the posterior bulge and two thinner tapered smooth setae between the bulge and the tibia plus a row of three short setae and a macrochaeta anterior to this margin; dorsally with one pectinate macrochaeta plus some smaller setae over the articulation, in addition to setae scattered over the mediad half of the dorsal surface, ventral surface with scales rather than setae. Tibia of PI with several very long carrot-shaped, slightly pectinate macrochaetae along most of the ventral margin as well as a few smaller setae on the margin and ventral face of distal half, external margin with stout setae denser in the distal half and two carrot-shaped macrochaetae on the ventral face remote from the margin about half way along its length; apex of tibia with two very long strong pectinate macrochaetae and the usual apical spur which has several setae but no small denticulations on the posterior margin. Tarsi of four articles, the basal tarsal article of PI about 40% of the total length of the tarsus, its join with the next article not particularly oblique, the ventral face of all tarsal articles with stout setae that are slightly rounded apically, especially near the distal end of each article where they are longer and stronger, dorsally with smaller setae. Pretarsus with two long curved lateral claws and a much shorter curved medial claw. PII and PIII (Figures 28–29) similar to PI with comb of only 2–3 smooth macrochaetae on the precoxa, lacking the antero-lateral comb on the coxae; legs progressively longer anterior to posterior with the tibia of PII being 1.4–1.5 times longer than that of PI and the tibia of PIII being 1.9–2.2 times longer than that of PI, the relative length of the basal tarsal article is progressively longer, being about 55% of the total length on PIII.

Abdomen: urotergite I with 1+1 lateral combs of 2–3 macrochaetae each comb associated with one or two marginal setae, urotergites II–VII (Figure 30) with 3+3 combs of macrochaetae as in table 2, the lateral combs also associated with 1–2 small marginal setae and a cilium at each end, the sublateral combs usually stand alone, rarely associated with a cilium, the submedial combs associated with a cilium at the laterad end of the comb; urotergite VIII with 2+2 combs, lacking the sublateral comb; urotergite IX glabrous. Urotergite X (Figure 31) almost equilateral triangular (67°) with rounded apex, wider than long (L/W at base about 0.56–0.63) with strong weakly pectinate setae close to the margins; with 0+1 combs of a single pectinate submarginal macrochaeta.

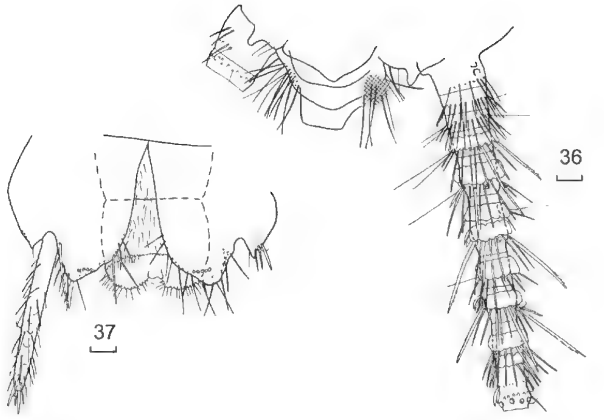
Urosternite I and II glabrous, urosternites III–VII with 1+1 lateral combs of 3–7 pectinate macrochaetae (Figure 32) each sometimes associated with 1–2 marginal setae but without a cilium.

TABLE 2 Number of macrochaetae per bristle comb *H. mutilloides* sp. nov.

Segment	Lateral Urotergite	Sublateral Urotergite	Submedial Urotergite	Urosternite
I	2–3	-	-	-
II	3	2	1–2	-
III	3	2	2	4
IV	4–5	2–3	1	5
V	4	2–3	2	5
VI	4	2	2	5–7
VII	4–5	3	1–2	7
VIII	5	-	1	4–7
IX	-		-	6–7



FIGURES 29–35 *Hemitelsella mutilloides* sp. nov. holotype ♀ (E109768); 29) PIII; 30) right side combs of urotergite IV; 31) urotergite X; 32) left sublateral comb of urosternite IV; 33) coxites VIII and IX and ovipositor, styli IX lost; 34) apical divisions of anterior gonapophyses; 35) apical divisions of posterior gonapophyses. All scale bars 0.1 mm.



FIGURES 36–37 *Hemitelsella mutilloides* sp. nov. holotype ♀ (E109768): 36) base of cerci, cross hatched area obscured; paratype ♂ (E109769): 37) coxites IX, penis and stylus. All scale bars 0.1 mm.

Genital region of female (Figure 33) with coxites VIII having quite rounded inner corners, each coxite bearing a comb of seven pectinate macrochaetae as well as two small marginal setae and a cilium at the lateral end; internal process of coxites IX short, 0.68–0.78 as long as wide at its base and only 2.0–2.5 times longer than the pointed external process, not reaching to the end of the ovipositor. Apex of internal process rounded with macrochaetae along much of the margins, a distinct transverse comb of 4–6 macrochaetae present but only occupying the mediad half of the process. — Ovipositor short (0.69–0.81 HW) of secondary type, slightly surpassing the apex of the short internal processes of coxites IX, both pairs of gonapophyses consisting of a long basal division (about half the length of the ovipositor), and six or seven smaller divisions; anterior gonapophyses (Figure 34) with six modified spines (conules) on the last division, plus one modified spine on each of the next three divisions which also have several long fine setae, posterior gonapophyses with seven conules or perhaps nine as the presumed suture between the group of seven and the following two conules could not be discerned, following divisions with long setae and each with a thicker more conical seta which becomes progressively thinner in the more anterior divisions (Figure 35).

Cerci (Figure 36) basal division about as long as wide with a partial ring of setae on outer side, following two divisions much wider than long, each with a single ring of setae as well as some trichobothria, divisions four and five with a broad ring of very dark rounded scales sub-basally which cover the insertion points of the ring of pectinate macrochaetae and smooth setae, divisions six and seven with a sub-basal ring of dark scales, then a ring of strong smooth macrochaetae and a trichobothrium then another ring of dark scales followed by the sub-apical ring of large pectinate macrochaetae, smooth setae and some cilia. Subsequent divisions lost. Median dorsal appendage lost.

Male: each coxite IX (Figure 37) with a transverse comb of about 4–5 macrochaetae across medial half of the inner process and a single macrochaeta on the face posterior to the transverse comb; the internal process not acute nor elongated, about twice as long as the external process but only 0.59–0.63 as long as broad at its base; external and internal margins of internal process and external margin of outer process with several long, often pectinate setae. Outer process small, acute triangular with a few robust setae along the outer margin. Only one pair of long slender styli (Figure 37) present (IX); each stylus with several short robust round-tipped macrochaetae apically. Styli IX in male holotype (excluding the apical macrochaetae) almost four times the length of the internal process. Penis typical (Figure 37) with numerous glandular setae apically, each set on a protuberance. Parameres absent.

HABITAT

Collected with trowel while free-roaming over yellow sandy clay soils in open woodland during daylight hours.

ETYMOLOGY

The species is named *mutilloides* because of its uncanny resemblance to velvet ants [Hymenoptera: Mutillidae].

Hemitelsella hortorum sp. nov.

Figures 5, 38–72

urn:lsid:zoobank.org:act:3D14BBE5-E922-4070-962C-084775D9699C

MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂ (HW 1.18) Flynn, Wandoo National Park (32.1045°S 116.5814°E), 17 October 2020, Jean and Fred Hort, hand collected on yellow sandy clay soil (WAM E109767) on two slides.

DIAGNOSIS

This species can be distinguished from *Hemitelsella transpectinata* (Smith) by its striking colour pattern when live (as well as other characters (see Table 4), but this pattern may be similar to that of *H. clarksonorum* and *H. mutilloides*. It can be distinguished from *H. clarksonorum* by the shorter length of the more posterior of the 3+3 combs of the prothoracic sternum versus 3+3 of subequal length, the reduced number of labial palp papillae (6–8 versus 8–9) and possibly by the arrangement of macrochaetae in the posterior trichobothrial areas of the mesonotum (three in line versus three in triangle) and from *H. mutilloides* by the almost square inner corner of coxites VIII (versus rounded) and the larger number of modified spines on the apex of the apical division of the ovipositor (3–4 versus 6–9).

DESCRIPTION

Appearance: medium sized silverfish, with narrow body, thorax not much wider than abdomen which only tapers slightly posteriorly from about the fifth abdominal segment. Appearance when live similar to *H. mutilloides* sp. nov. (Figure 5) resembling a velvet ant (Mutillidae) with anterior third even reddish brown and posterior two thirds black with white patches on the lateral sides of the anterior five abdominal segments as well as medially on the anterior three or four urotergites, urotergite X also with white medial patch, styli IX white, terminal filaments black; legs reddish brown. In alcohol, head uniformly covered with reddish-brown scales, without wide areas of hyaline scales along the sides and front of the head; pro and meso nota also fairly evenly covered in brown scales, metanotum and urotergite I with darker scales submedially but lighter scales medially and at outer margin, urotergites II–III also with darker scales along margins, these darker scales surround distinct circular light patches on IV–VI but these patches become more indistinct on urotergites VII–IX; eyes dark grey. Terminal filaments very dark due to brown pigment and black scales.

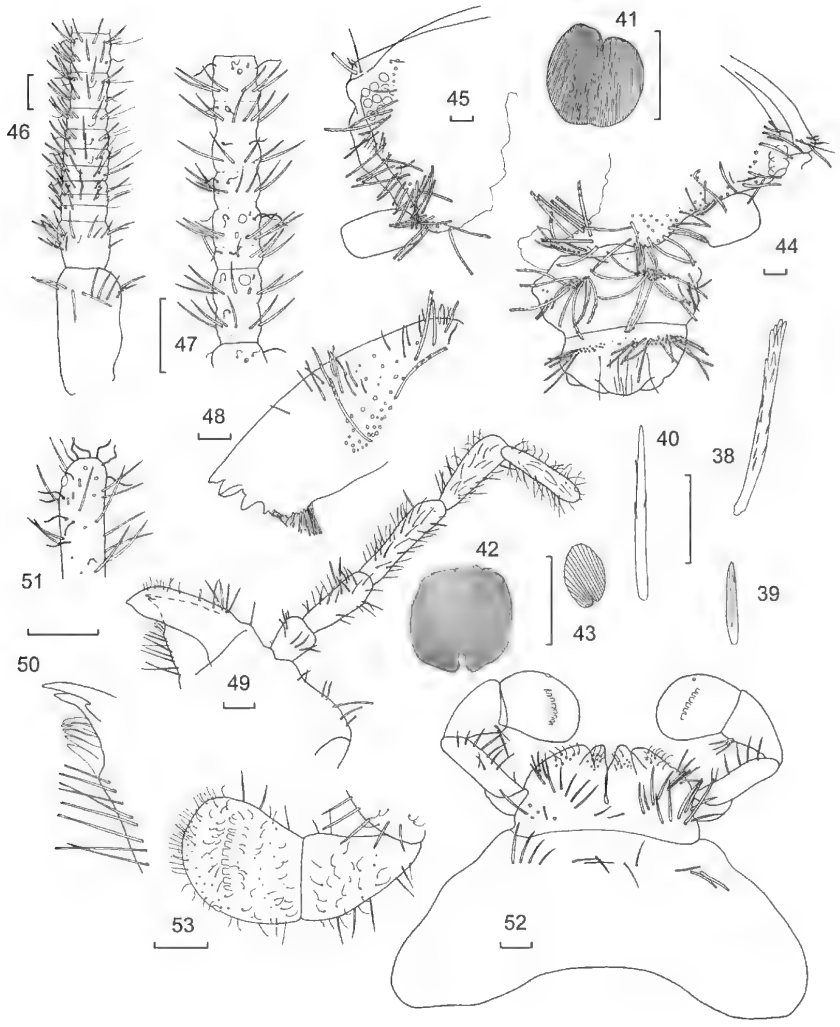
Body length: 8.05 mm (♀); head width 1.26 mm; thorax: length 2.4 mm or 0.30 H+B; width up to 1.54 mm with no great difference between the pro, meso and metanota although the mesonotum is the widest and the pronotum the narrowest; antenna incomplete (?) 4.6 mm or 0.57 times H+B; terminal filaments all incomplete; maximum length of median dorsal appendage remaining 2.8 mm or 0.34 H+B.

Pigmentation: frons, clypeus and labrum without obvious pigment, pedicel and scape slightly darker, the intervals of the flagellum becoming increasingly darker distally. mandibles, maxillae and labium evenly but lightly pigmented, maxillary palp with medium reddish-brown pigment on all articles, somewhat less in distal articles, labial palp with very little pigment, just a little laterally on the sides of the three distal-most articles, legs with reddish-brown pigment overall, becoming stronger in more distal articles, more reddish along all lateral margins before dissection which may be due to scales as the pigmentation looks quite even in the slide mounted material; prothorax with very slight pigmentation along notal collar and antero-lateral corners, otherwise nota, urotergites and sternites appear to be unpigmented, styli without pigment, cerci and median filament reddish-brown, darker distally. Inner process of coxites IX pigmented in alcohol but this not visible in slide mounted material. Ovipositor with distinct orange lines of pigment along suture but only before dissection.

Macrochaetae: pectinate and of variable form (Figures 38–40), mostly light to quite dark brown, but hyaline or straw coloured in some cases. The macrochaetae along the edges of the nota do not have bifurcated apices and only very subtle pectinations along the shaft and quite different to the submarginal macrochaetae which are obviously pectinate especially apically. The larger setae of the tarsi are strongly sclerotised and have rounded tips.

Scales: with numerous subparallel ribs that do not surpass the margin of the scale, with ribs mostly close together or even very close together in the darker scales but a rare few scales observed (e.g. on frons) where the ribs are comparatively far apart (Figures 41–43); shape of scales generally round, although the posterior margin can be quite straight for those scales overhanging the posterior margins of the tergites and others are shaped to fit around setae or combs. Scales found on top of head, medially on clypeus, scape, all nota, all thoracic sterna, legs but absent from trochanter and tarsi, present on all urotergites and urosternites, styli and on parts of the terminal filaments. Scales of the terminal filaments very diverse in shape including some very broad as well as lanceolate scales.

Head: wider than long (Figures 44–45), with 1+1 weak bushes of pectinate macrochaetae on the antero-lateral corners, not very dense and only weakly aligned in distinct rows. Any gap along the margin above the antennae hard to distinguish and the macrochaetae continue along the margin about two macrochaetae wide to the level of the eyes and then running above the eyes and beyond the eyes. The 1+1 peri-antennal groups not obviously isolated from marginal rows consist of only three to five macrochaetae without any associated cilia or long thin setae. Eyes with each dark grey ommatidium isolated from the adjacent ommatidia by light grey areas.



FIGURES 38–53 *Hemitelsella hortorum* sp. nov., holotype ♀ (E109767): 38) pectinate macrochaeta of head; 39) carrot-shaped macrochaeta from margin of nota; 40) finely pectinate macrochaeta of cercus; 41) darker scale from face of pronotum; 42) darker scale from margin of urotergite; 43) scale with wider rib spacing on frons; 44) head, left side, including clypeus and labrum; 45) head, right side; 46) antenna, scape, pedicel and basal articles of flagellum; 47) idem, most distal surviving article; 48) mandible; 49) maxilla; 50) idem, apex of lacinia: 51) idem, ultimate article of palp; 52) labium, minor setae of palp omitted; 53) idem, apical articles of maxillary palp. Scale bars 0.1 mm.

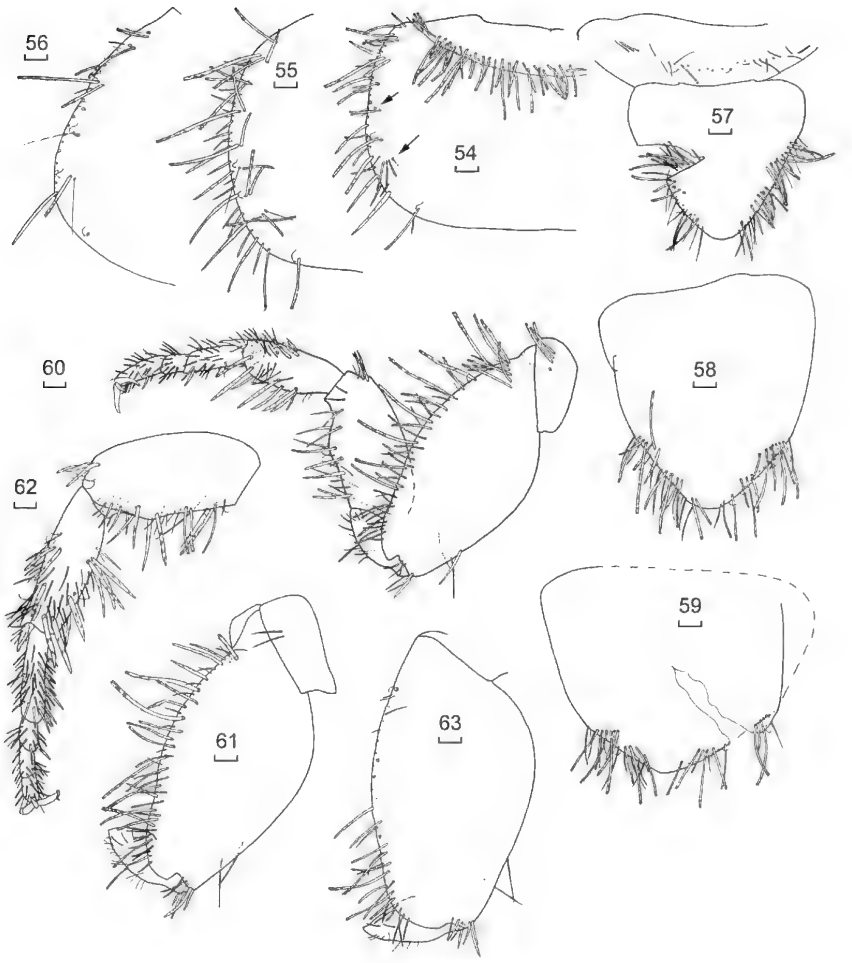
Clypeus with 1+1 bushes of about 20–25 macrochaetae slightly separated from smaller (2–5 macrochaetae) more antero-lateral groups, 1+1 setae between the larger bushes close to the posterior margin. Labrum also with 1+1 bushes of about 30 pectinate macrochaetae as well as a few simple setae and two lines of four thin setae, one about midway along the labrum the other three quarters behind the anterior end. — Scape of antenna (Figure 46) quite long with scales over surface and short robust simple subapical setae, pedicel with two or three rings of setae, first annulus (interval) of flagellum with a partial ring of setae, intervals two to seven of flagellum each of a single annulus with a single ring of setae, cilia and at least 2–3 trichobothria, intervals eight and nine subdivided into two annuli each with a ring of setae and cilia, two trichobothria only in the most distal ring, intervals 10 and 11 subdivided into three annuli and beyond the twelfth into four annuli

again with the trichobothrium in the most distal ring and eventually subdividing into eight annuli per interval (Figure 47), when the trichobothria no longer appear to be present but circular sensilla (poculiform of Mendes, 1986d)) become larger in size and more obvious on the second and fourth most basal annuli, the most distal annulus with a smaller raised circular sensillum (like 'Sensilla of Silvestri' in Mendes, 1986d) and a basiconic sensillum type B (of Adel, 1984). — Mandibles (Figure 48) typical for Ctenolepismatinae with well-developed molar and incisor areas; a group of about ten strong and short or thin and longer, apically bifurcated setae distally adjacent to the pectinate molar area and a bush of about 40 macrochaetae externally. — Maxilla (Figure 49) with one thick apically bifurcate macrochaeta and several simple setae externally proximal to the palp, the lacinia (Figure 50) with three strong teeth, one set further back than the other two, followed by about six lamellate processes and a row of eight thin simple setae, galea with several strong, smooth, pointed setae externally in its basal half and a few cilia distally; apical article of maxillary palp (Figure 51) 3.5 times longer than wide and only slightly longer than the penultimate article, the ultimate article with three rod-like basiconic sensilla and a poculiform sensilla near the apex, last three articles of palp with simple setae only although some thicker than others, two basal articles with subapical rings of slightly thicker setae. — Labium (Figure 52) wider than long, prementum with an interrupted transverse row of smooth strong setae, glossae and paraglossae with lateral and oblique groups of strong apically bifurcated setae and with short curved setulae distally; labial palp with oval/subrectangular apical article, not greatly widened medially (Figure 53), 1.1 times longer than wide with 6–8 papillae arranged in a single curved row, with at least one poculiform sensilla on the outer margin, covered with numerous fine short setae as well as longer fine setae on along the distal end; penultimate article as long as the ultimate article.

Thorax: pronotum (Figure 54) with narrow setal collar about two macrochaetae wide and some setae but no cilia; lateral margins with many strong smooth and subtly pectinate macrochaetae along the margins as well as some submarginal setae and a few cilia, with eight submarginal combs of 1–3 strongly pectinate macrochaetae, the anterior trichobothrial area about 0.44 along the margin associated with comb N-2 (terminology of Molero-Baltanás, 2010) the trichobothrium located between the mediad strongly pectinate macrochaeta and a strong smooth marginal macrochaeta, the posterior trichobothrium located at the mediad end of a comb of three pectinate macrochaetae located about 0.70 distance along the margin. Posterior margin with 1+1 single macrochaetae each associated with a marginal seta and a cilium, the posterior combs being positioned quite laterally and almost contiguous with the chaetotaxy of the lateral margin. — Mesonotum (Figure 55) with lateral chaetotaxy similar to pronotum with 7–8 combs of one to three pectinate macrochaetae, the anterior trichobothrial area located about 0.63 along the lateral margin, associated with comb N-2 of just one macrochaeta with the trichobothrium located between the macrochaeta and the margin and with a cilium between the trichobothrium and the seta on the margin. Posterior trichobothrial area 0.78 along margin, the trichobothrium located mediad of a group of three macrochaetae (=N) arranged in a line not in a triangle, (which was an unusual arrangement reported in the description of the single known specimen of *H. clarksonorum*). Posterior margin with quite laterad 1+1 combs each of a single macrochaeta with a cilium at the outer end and a marginal seta. — Metanotum (Figure 56) similar to mesonotum but with only six combs of one or two macrochaetae, the anterior trichobothrial area associated with the comb (N-1) of just one macrochaeta about 0.57 along the margin, the posterior trichobothrial area associated with the most posterior comb (N) of a single macrochaeta about 0.72 along the margin and the posterior 1+1 combs again quite laterad with a single macrochaeta and a laterad cilium.

Presternum narrow, with weak transverse row of short pectinate macrochaetae and smooth setae (Figure 56). All thoracic sterna with hyaline scales. — Prothoracic sternum (Figure 57) wider at base than long, (L/W 0.75) subtriangular, rounded posteriorly, antero-lateral corners without fringe of setae, posterior three quarters of lateral margins with long simple setae as well as 3+3 combs of 8–9, 5–5 and 1–2 pectinate macrochaetae (anterior to posterior) running at an angle of about 20° to the margin. — Mesosternum (Figure 58) about as wide as long (L/W 1.05) and 1.5 times as long as the prosternum, with long, thin simple marginal setae and a few cilia around the distal half of the margin, 3+3 combs in its distal third, with 6–7, 3–4 and 2 pectinate macrochaetae per comb (anterior to posterior). — Metasternum (Figure 59) apically slightly pointed, about 1.4 times wider than long (L/W 0.73) with long marginal setae and cilia along distal one third of lateral margins and 2+2 combs of longer and shorter pectinate macrochaetae, the more proximal with six macrochaetae the more distal with 4–5 although the most distal macrochaeta of each comb is somewhat more distantly spaced from the others suggesting it could be seen as a separate comb in some individuals.

Legs (Figures 60–63) becoming progressively longer and more slender, tibia L/W ratio of legs PI 2.5, PII 3.5, PIII lost; tarsi L/W ratio PI 4.5, PII 6.4, PIII lost. PI (Figure 60) with comb of four macrochaetae laterally on precoxa. Coxa with scales and a comb of about six macrochaetae on the anterolateral corners followed by many strong pectinate macrochaetae along the external margin, never grouped into combs of two macrochaetae, the more marginal macrochaetae being much less pectinate, curved and tapering; inner margin with a macrochaeta on the margin and two long thin setae on the dorsal face and about five setae of varying thickness



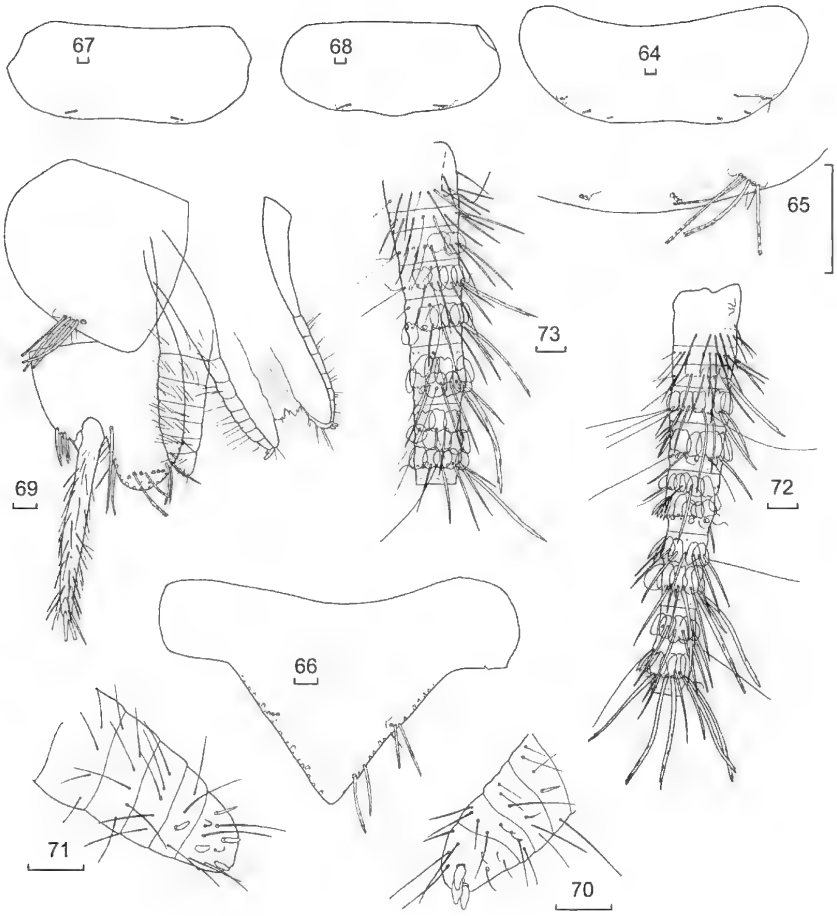
FIGURES 54–63 *Hemitelsella hortorum* sp. nov., holotype ♀ (E109767): 54) pronotum, left half; 55) mesonotum, left half; 56) metanotum, left half; 57) presternum and prothoracic sternum; 58) mesothoracic sternum; 59) metathoracic sternum; 60) PI; 61) PII, coxa and trochanter; 62) PII, femur, tibia and tarsus; 63) PIII, coxa and trochanter. All scale bars 0.1 mm.

distally over the articulation. Femur ventrally with several strong, thick pectinate tapering macrochaetae and dorsally with three pectinate macrochaetae over the articulation in addition to setae scattered over the mediad half of the dorsal surface, ventral surface with scales rather than setae. Tibia of PI with several very long carrot-shaped, slightly pectinate macrochaetae along most of the ventral margin as well as a few smaller setae on the margin and ventral face of distal half, external margin with group of stout setae about half the distance along the margin; apex of tibia with two stout pectinate macrochaetae and the usual apical spur which has several seta but no small denticulations on the posterior margin. Tarsi of four articles, the basal tarsal article of PI about 40% of the total length of the tarsus, its join with the next article not particularly oblique, the ventral face of all tarsal articles with stout setae that are not conspicuously rounded apically, stout setae which are longer near the apex of each article, dorsally with similar setae. Pretarsus with two long curved lateral claws and a much shorter curved medial claw. PII (Figures 61–62) similar to PI except PII with comb of only two smooth macrochaetae on the precoxa, lacking the antero-lateral comb on the coxae; legs progressively longer anterior to posterior with the tibia of PII being 1.5 times longer than that of PI; PIII lost beyond trochanter (Figure 63).

Abdomen: urotergite I with 1+1 lateral combs of three macrochaetae each comb associated with one or two marginal setae and a cilium at the laterad end of the comb, urotergites II–VII (Figures 64–65) with 3+3 combs of macrochaetae as in table 3, the lateral combs also associated with 1–2 small marginal setae or setulae and one or two cilia, always at the laterad end of the comb but usually at both ends, the sublateral combs usually stand alone, rarely associated with a small seta or setulae (all lost), the submedial combs associated with a cilium at the laterad end of the comb; urotergite VIII with 2+2 combs, lacking the sublateral comb; urotergite IX glabrous. Urotergite X (Figure 66) almost equilateral triangular (73°) with slightly rounded apex, wider than long (L/W at base about 0.60) with strong weakly pectinate setae close to the margins; with 2+2 combs of one or two pectinate macrochaetae per comb.

Urosternite I and II glabrous, urosternites III–VII with 1+1 lateral combs of 4–7 pectinate macrochaetae (Figures 67–68) (all lost from holotype) each usually associated with 1–2 thin marginal setae or setulae and always with a cilium at the laterad end of the comb.

Genital region of female (Figure 69) with coxites VIII having almost square inner corners, each coxite bearing a comb of 5–7 pectinate macrochaetae as well as two small marginal setae and a cilium at the lateral end; internal process of coxites IX short, 0.58–0.60 as long as wide at its base and only 2.4–3.8 times longer than the pointed



FIGURES 64–73 *Hemitelsella hortorum* sp. nov., holotype ♀ (E109767): 64) urotergite III; 65) urotergite VI, right side combs; 66) urotergite X; 67) urosternite VI; 68) urosternite VII; 69) right coxites VIII and IX, ovipositor and stylus IX; 70) apex of anterior gonapophysis; 71) apex of posterior gonapophysis; 72) base of cercus; 73) base of median dorsal appendage. All scale bars 0.1 mm.

TABLE 3 Number of macrochaetae per bristle comb *Hemitelsella hortorum* sp. nov.

Segment	Lateral Urotergite	Sublateral Urotergite	Submedial Urotergite	Urosternite
I	3	-	-	-
II	3	3	2	-
III	3–4	3	2	4
IV	4	3	2	5
V	4–5	3	2	5
VI	5–6	3	2	5
VII	5	3–4	2	6
VIII	5	-	2	5–7
IX	-	-	-	

external process, almost as long as the ovipositor. Apex of internal process rounded with macrochaetae along much of the margins, a distinct transverse comb of 8–10 macrochaetae present. — Ovipositor short (0.62 HW), only just reaching the apex of the short internal processes of coxites IX, both pairs of gonapophyses consisting of a long basal division (about half the length of the ovipositor) and six or seven smaller divisions (Figure 70); of secondary type, anterior gonapophyses with 2–3 modified spines on the last division, as well as several long fine setae plus one or two stout seta on the third and fourth last divisions, posterior gonapophyses with 2–3 on the last division and sometimes one on the penultimate division (Figure 71), with also with long fine setae.

Cerci (Figure 72) basal division about as long as wide with one or two partial rings of setae on outer side (but may actually be two divisions with an indistinct suture separating them), following division much wider than long with a single ring of setae as well as some trichobothria, subsequent three divisions increasing in length with a basal ring of wide round scales and a subapical ring of setae, macrochaetae, cilia and trichobothria; sixth, seventh and eighth divisions longer than wide with a sub-basal ring of scales, followed by a ring of setae and long trichobothria, then a ring of scales, the outer most of which are lanceolate and a subdistal ring of setae, pectinate macrochaetae and cilia but lacking trichobothria; ninth division with six rings, three of which are scales, pectinate macrochaetae confined to the most distal ring and trichobothria to the second ring; tenth division with four rings of setae and four of scales, although some scales appear on rings predominantly of setae and some setae can be found on rings predominantly of scales, trichobothria restricted to the second most basal ring of setae; trichobothria and round scales appear to be absent or only very small on most distal surviving divisions but some lanceolate scales can be found. — Median dorsal appendage (Figure 73) with longer first division bearing two rings of small setae and trichobothria, the setae above simple while those below are noticeably pectinate, following three divisions about 2–3 times as long with a subapical ring of setae, cilia and trichobothria, as well as having a sub-basal ring of broad scales and a short trichobothria; sixth division similar but with an additional ring of broad scales in the middle of the division; seventh division longer again with three distinct rings of broad setae and two of setae, macrochaetae restricted to the most distal ring. Most distal surviving divisions (probably about two thirds of undamaged length) with five rings of pectinate setae, the macrochaetae of the most distal ring not much larger than the setae of the other rings, scales no longer visible, trichobothria, present in some annuli but consistent pattern not defined.

Male: unknown.

HABITAT

Collected with trowel while free-roaming over yellow clay sandy soils in open woodland during daylight hours. The Hort's noted on their web-posting of the image that

> 'This pretty silverfish runs around in the daytime in relatively open sandy soil between shrubs and leaf litter. They look like ants hurrying across the ground as mostly all you see is the black section of the body.
>
> I watched this one move over the ground and was surprised to see it move tiny rocks and push its head against the rock and sit very still. At one stage it raised the rear of its abdomen and waved the cerci and filament around in circles.
>
> I think they are very pretty especially seeing the rainbow colours reflected in its scales.'

ETYMOLOGY

The species is named for the discoverers of the species, Jean and Fred Hort.

DISCUSSION

MOLECULAR DATA AND SPECIES BOUNDARIES

In contrast to the results obtained for the Heterolepismatinae (Smith et al., 2019) where we failed to identify morphological differences between clades with comparatively large DNA distances of 0.9–1.8% for 28S and 7.2% for COI, we find quite pronounced differences in morphology between two species that have identical 28S sequences and 5.2% difference in COI. Based on characters usually considered as stable within the Ctenolepismatinae (the arrangements of combs on the thoracic sternites, the number of labial palp papillae and the shape of the inner corners of coxites IX) as well as the greatly different scale pattern there seems little

doubt that all four species are distinct. *Hemitelsella clarksonorum* and *H. hortorum* have however, only been described from single specimens, so we have no knowledge of morphological variability in these species. It would appear that the molecular differences between morphologically distinct species, are considerably smaller than observed in the Heterolepismatinae and more in line with that observed in other more recent insect orders.

Smith (2018) considered the Heterolepismatinae to have originated in the proto-Australian part of Gondwana after it broke away from Africa. The subfamily predominates now in the moister forested parts of the Australian continent and only a few species have been collected in desert habitat. It is present on many islands in the Pacific and seems to be able to survive ocean crossings better than to thrive in a desert. In contrast, the Ctenolepismatinae predominate in desert habitats of Africa, Australia and Central Asia. The Australian genera (*Acrotelsella*, *Qantelsella*, *Hemitelsella*) are totally distinct at the genus level from those found in Africa and Central Asia (*Ctenolepisma*, *Thermobia* and a number of highly adapted psammophilous genera). Several Ctenolepismatinae species have been shown to absorb moisture through their rectum at relative humidity levels as low as 45.7% (Edney, 1971) and can be abundant in the driest of deserts (e.g. the Kalahari sand desert). We suggest that the Ctenolepismatinae have been more successful at adapting to the drier climate resulting from Australia's drift northward and are morphologically evolving more rapidly, occupying new niches. The Heterolepismatinae, on the other hand appear to be highly conserved morphologically and perhaps already optimally adapted for the niche they occupy (generally the bark of trees or leaf litter protected from rain) but somehow also limited to this niche. They might not be as efficient at moisture control. Smith (2020) observed specimens of *Heterolepisma sclerophyllum* Smith, 2014 apparently taking up moisture from wet cotton wool with their mouth. Perhaps their physiology is less suited to drier conditions and their distribution has contracted along with the forests, rather changing morphologically to the increasingly drier environment. There is however at least one species (*Heterolepisma parvum* Smith) that has been collected in large numbers on arid Barrow Island, suggesting that some species have been able to adapt to aridity.

MORPHOLOGY

When *Hemitelsella transpectinata* (Smith) was originally described from material in alcohol, the presence of longitudinal lines of darker scales on the thorax and anterior abdomen was striking enough that the author attempted to illustrate this pattern. When a second species (*Hemitelsella clarksonorum*) was sent to the author (also in alcohol), the colour pattern appeared to be quite different with no darker bands on the thorax. Placing the original illustrations alongside the photos of the two new western Australian species it would appear that *H. clarksonorum* could be very similar in colour pattern and hence probably also a mutillid mimic.

TABLE 4 Table of characters of described *Hemitelsella* species.

	H. clarksonorum	*H. hortorum*	*H. mutilloides*	*H. transpectinata*
Thorax colour pattern	Even reddish-brown	Even reddish-brown	Even reddish-brown	White margins, two longitudinal lines
Prosternum L/W (approx.)	0.8	0.75	0.73	1.0
Prosternum combs	3+3 subequal in length	3+3 anterior combs longer	3+3 anterior combs longer	(4–6)+(4–6) subequal or slightly longer anteriorly
Labial palp papillae	8–9	6–8	6	11–12
Macrochaetae in posterior mesonotal trichobothrial area	3 in triangle	3 in line	3 in line	3 in line
Macrochaetae per comb coxites VIII	8–9	4–7	5–7	7–11
Shape inner corners coxites VIII ♀	unknown	subsquare	round	subsquare
Spines on apical division of ovipositor	unknown	3–4	6–9	3–4

Hemitelsella transpectinata appears to be quite different in scale pattern. Molecular data however show that, in spite of the pattern differences, *H. clarksonorum* and *H. transpectinata* are quite closely related, whereas much greater molecular differences are observed between the new species and *H. clarksonorum* in spite of their apparently similar colour patterns. Further species of *Hemitelsella* have been collected in Western Australia and South Australia, however we do not have photos of them when live, depriving us of what appears to be a remarkably interesting and useful character.

While the colour pattern makes it easy to distinguish *H. transpectinata* from the other three species, morphological differences between the latter are more subtle. Table 4 summarises the differences between all four species. However, with the exception of *H. transpectinata*, we have seen very few specimens of the other three species and the female of *H. clarksonorum* is unknown. It is possible, indeed likely, that the range of variability for some of these characters will render them less useful, especially with regards to juvenile specimens.

BATESIAN MIMICRY

These species appear to represent the first instances of Batesian mimicry in the Zygentoma. Their similarity to velvet ants probably discourages potential predators allowing them to be active in daylight hours and on open ground.

ACKNOWLEDGEMENTS

Thanks are due to Jean and Fred Hort for noticing these amazing animals in the field, posting their images online and collecting specimens for us. We would also like to thank Graham Brown (Northern Territory Museum and Art Gallery), Kevin Williams (California Department of Food and Agriculture), Juanita Rodriguez and Madalene Giannotta (Australian National Insect Collection) for their valued opinion as to whether these silverfish were likely to be mimicking velvet ants.

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New species of the pseudoscorpion genus *Synsphyronus* (Pseudoscorpiones: Garypidae) from Australia

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ABSTRACT – The pseudoscorpion genus *Synsphyronus* is endemic to the Australasian region with 30 species from Australia, two from New Zealand, and one from New Caledonia. Seven new species are described from Australia mostly based on specimens collected on various BushBlitz expeditions: *S. codyi* sp. nov., *S. patricki* sp. nov., *S. pharangites* sp. nov., *S. samueli* sp. nov. and *S. xynus* sp. nov. from Western Australia, and *S. marinae* sp. nov. and *S. sertus* sp. nov. from the Northern Territory. Like other species of *Synsphyronus*, all species have reduced trichobothrial numbers on at least one chelal finger, with *S. codyi*, *S. patricki*, *S. samueli* and *S. sertus* having eight trichobothria on the fixed finger and three on the movable finger (denoted as 8/3), *S. marinae* has 8/2, *S. xynus* has 8/1 and *S. pharangites* has 7/1. Five of the new species (*S. codyi*, *S. marinae*, *S. pharangites*, *S. sertus* and *S. xynus*) have fused metatarsi and tarsi, which brings the total number of species with this neotenic feature to 12 of the 40 named species. Certain meristic data for *S. gurdoni* Harvey, Abrams and Burger, 2015 are corrected. Six of the new species have only been found at a single location, despite concentrated searching for additional specimens in adjacent habitats, and may have very small distributions indicative of short-range endemism. The seventh species, *S. xynus*, is widely distributed in the Pilbara region of Western Australia. COI barcode data are provided for *S. marinae*, *S. sertus* and *S. xynus*.

KEYWORDS: taxonomy, morphology, short-range endemics, BushBlitz, COI barcode

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INTRODUCTION

The pseudoscorpion family Garypidae is represented by two subfamilies with dissimilar distributions. Garypinae includes 34 species of *Garypus* L. Koch, 1873 and three species of *Anchigarypus* Harvey, 2020, all from supralittoral habitats mostly in tropical and subtropical regions of the world (e.g. Beier 1963; Chamberlin 1921; Harvey 2021; Harvey et al. 2020; Hummelinck 1948; Lee 1979; Mahnert 1982b). Synsphyroninae includes 57 species in nine genera from Africa, Madagascar, the Arabian Peninsula, Australasia and various islands in the Indian Ocean (Harvey 2013). Seven of these genera are restricted to the Afrotropical region where they are generally found in rocky outcrops and desert habitats: *Ammogarypus* Beier, 1962, *Elattogarypus* Beier, 1964, *Eremogarypus* Beier, 1955, *Meiogarypus* Beier, 1955, *Neogarypus* Vachon, 1937, *Paragarypus* Vachon, 1937 and *Thaumastogarypus* Beier, 1947 (e.g. Beier 1947; Beier 1955, 1958, 1962, 1964c, 1973; Mahnert 1982b, 1984b, 2007; Vachon 1937a, b). Two others occur outside of Africa. *Anagarypus* Chamberlin, 1930 has been recorded from northern Australia and several Indian Ocean islands where they occur under rocks or log bark near the seashore (Beier 1981; Chamberlin 1930; Muchmore 1982). The largest synsphyronine genus, *Synsphyronus* Chamberlin, 1930, is endemic to Australasia where there are currently 33 named species (e.g. Beier 1966b, 1971; Chamberlin 1930, 1943; Harvey 1987b, 2011, 2012, 2020; Harvey et al. 2015a). Most species have been described from Australia, including Tasmania, but two are endemic to New Zealand (Beier 1966b; Chamberlin 1930; Harvey 1987b), and another is endemic to New Caledonia (Harvey 2020). Many additional unnamed

species are also known from Australia that mostly occur under rocks or tree bark in semi-arid and arid ecosystems (Harvey, unpublished data).

One of the most interesting aspects of the morphology of *Synsphyronus* species is the lability of two features that are relatively well conserved in other pseudoscorpion genera. The first is the fusion of the metatarsus and tarsus in the adults of some species. This feature was used by Chamberlin (1930) to distinguish *Synsphyronus* from Australia from the morphologically similar *Maorigarypus* Chamberlin, 1930 from New Zealand which retained the non-fused condition found in other garypids. After discovering two morphologically similar species that had either condition, Chamberlin (1943) synonymized *Maorigarypus* with *Synsphyronus*.

The second feature comprises differences in the number of trichobothria on the chelal fingers. While most adult pseudoscorpions have eight trichobothria on the fixed finger and four on the movable finger, there are numerous alternative states (Harvey 1992). For example, all species of the neobisioid family Ideoroncidae have supernumerary trichobothria on both fingers (e.g. Harvey 1992; Harvey 2016; Harvey and Du Preez 2014; Harvey and Muchmore 2013; Mahnert 1981, 1984a) ranging from 17 to 32 in number and all Menthidae have 11 trichobothria on the fixed finger (e.g. Harvey 1992; Harvey and Muchmore 1990). Reductions in trichobothrial number are far more common, occur independently in several different families, and most likely result from neoteny (Sakayori 1989). Examples include the presence of seven trichobothria on the fixed finger of *Microbisium* Chamberlin, 1930 (family Neobisiidae) (e.g. Beier 1963; Nelson 1984; Sakayori 1989), *Microblothrus* Mahnert, 1985 (Syarinidae) (Mahnert 1985), *Anagarypus* Chamberlin, 1930 (Garypidae) (Muchmore 1982), several genera of Garypinidae (*Aldabrinus* Chamberlin, 1930, *Galapagodinus* Beier, 1978, *Nelsoninus* Beier, 1967 and *Paraldabrinus* Beier, 1966) (Beier 1966a, 1967, 1976, 1978; Mahnert 2014; Muchmore 1974), two species of *Geogarypus* (Geogarypidae) (Harvey 1986, 1987a), most genera of Cheiridiidae (but occasionally with five or six) (e.g. Beier 1963; Benedict 1978; Harvey 1992; Mahnert 1982a; Vitali-di Castri 1962), Sternophoridae (e.g. Harvey 1985), *Canarichelifer* Beier, 1965 (Cheliferidae) (Beier 1965), and *Anaperochernes* Beier, 1964 (Chernetidae) (Beier 1964a, b). Some genera have even fewer fixed finger trichobothria including *Paedobisium* Beier, 1939 (Neobisiidae) (Beier 1939, 1963; Cîrdei et al. 1967) with six trichobothria, *Elattogarypus* Beier, 1964 and *Meiogarypus* Beier, 1955 (Garypidae) (Beier 1955, 1964c; Mahnert 1984b, 2007) and *Solinellus* Muchmore, 1979 (Garypinidae) with five trichobothria (Muchmore 1979). The reduction in trichobothria on the movable finger is even more prevalent, with many species in various families having three, two or even only one trichobothrium; however, there are too many instances to mention here.

Although the standard trichobothrial pattern in *Synsphyronus* is 8/3 (i.e. eight trichobothria on the fixed finger and three trichobothria on the movable finger), several other configurations occur, including 8/2, 8/1, 7/2, 7/1 and 6 (or rarely 5)/2 (Harvey 1987b, 2011, 2012, 2020; Harvey et al. 2015a). This lability is unusual for most pseudoscorpion genera and has led to some taxonomic confusion in the past. One of the features cited by Chamberlin (1943) to justify the recognition of the new genus *Idiogarypus* Chamberlin, 1943 for *S. hansenii* (With, 1908) from Tasmania was the purported presence of only seven trichobothria on the fixed finger. Morris (1948) demonstrated that specimens of *S. hansenii* (With, 1908), possessed eight trichobothria on the fixed finger and duly synonymized *Idiogarypus* with *Synsphyronus*.

This paper reports the discovery of seven previously undescribed species of *Synsphyronus* mostly collected from the western half of mainland Australia during several BushBlitz expeditions. BushBlitz is a nature discovery program that seeks to collect and document Australia's biodiversity by organising expeditions to remote locations (see https://bushblitz.org.au/).

MATERIAL AND METHODS

The material utilized in the present study is lodged in the Australian Museum, Sydney (AM), Museum and Art Gallery of the Northern Territory, Darwin (NTM), Queensland Museum, Brisbane (QM) and the Western Australian Museum, Perth (WAM). The specimens were examined by preparing temporary slide mounts by immersing the specimen in 75% lactic acid at room temperature for one to several days, and mounting them on microscope slides with 10 or 12 mm coverslips supported by small sections of nylon fishing line. Specimens were examined with a Leica MZ16 dissecting microscope, a Leica DM2500 or Olympus BH–2 compound microscopes, and illustrated with the aid of a drawing tube. Measurements (in mm) were taken at the highest possible magnification using an ocular graticule. After study the specimens were rinsed in water and returned to 75% ethanol with the dissected portions placed in 12 × 3 mm glass genitalia microvials (BioQuip Products, Inc.).

Terminology and mensuration largely follow Chamberlin (1931), with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992), chelicera (Harvey and Edward 2007; Judson 2007) and faces of the appendages (Harvey et al. 2012).

Molecular sequence data were obtained from three of the nine species of *Synsphyronus* described here (Table 1). The techniques used to obtain the Cytochrome Oxidase 1 sequence data are outlined in Harvey et al. (2015b) and Harvey et al. (2020).

TABLE 1 Specimens used to generate COI barcodes of three species of *Synsphyronus*.

Species	Registration No.	Sex and type status	Locality	GenBank No.
Synsphyronus marinae sp. nov.	WAM T124420	Female paratype	NT, Wongalara Wildlife Sanctuary, Herbert Bluff	MZ920049
Synsphyronus sertus sp. nov.	WAM T131645	Male paratype	NT, Henbury Station, James Range, c. 7 km WNW. of Mt Keartland	MZ934365
Synsphyronus xynus sp. nov.	WAM T135584	Male holotype	WA, Karijini National Park, c. 20 km SW. of Hancock Gorge	OK489973
	WAM T135549	Female paratype	WA, Karijini National Park, c. 20 km SW. of Hancock Gorge	OK489972
	WAM T82355	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK255296
	WAM T82356	Male	WA, Mesa K, 10 km SW. of Pannawonica	OK255297
	WAM T107400	Female	WA, Hope Downs, 74 km NW. of Newman	OK272544
	WAM T108727	Male	WA, Area C, 27.2 km NE. of Tom Price	OK272545
	WAM T108732	Male	WA, Area C, 27.2 km NE. of Tom Price	OK272546
	WAM T111892	Female	WA, Southern Flank to Jinidi, 68.1 km NW. of Newman	OK489974
	WAM T127500	Deutonymph	WA, BlueSpec, 18 km NE. of Nullagine	OK489975
	WAM T133100	Tritonymph	WA, Sulphur Springs	OK272547
	WAM T133101	Male	WA, Sulphur Springs	OK272548
	WAM T133102	Male	WA, Sulphur Springs	OK489976
	WAM T133103	Female	WA, Sulphur Springs	OK272549
	WAM T133104	Female	WA, Sulphur Springs	OK272550
	WAM T133105	Male	WA, Sulphur Springs	OK272551
	WAM T133106	Male	WA, Sulphur Springs	OK489977
	WAM T133107	Male	WA, Sulphur Springs	OK489978
	WAM T133108	Male	WA, Sulphur Springs	OK489979
	WAM T133109	Female	WA, Sulphur Springs	OK489980
	WAM T133110	Male	WA, Sulphur Springs	OK489981
	WAM T133112	Male	WA, Sulphur Springs mine	OK489982
	WAM T133113	Male	WA, Sulphur Springs mine	OK489983

Species	Registration No.	Sex and type status	Locality	GenBank No.
	WAM T133114	Male	WA, Sulphur Springs mine	OK489984
	WAM T133115	Male	WA, Sulphur Springs mine	OK489985
	WAM T133116	Male	WA, Sulphur Springs mine	OK489986
	WAM T133117	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489987
	WAM T133118	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489988
	WAM T133119	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489989
	WAM T133120	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489990
	WAM T133121	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489991
	WAM T133122	Female	WA, Mesa K, 10 km SW. of Pannawonica	OK489992
	WAM T133123	Male	WA, Mesa K, 10 km SW. of Pannawonica	OK489993
	WAM T133124	Tritonymph	WA, Mesa K, 10 km SW. of Pannawonica	OK272552
	WAM T133125	Male	WA, Mesa K, 10 km SW. of Pannawonica	OK272553
	WAM T133126	Female	WA, Tom Price Powerline, 1 km WSW. of Tom Price	OK272554
	WAM T133129	Female	WA, near Sulphur Springs	MN058679
	WAM T133130	Male	WA, near Sulphur Springs	OK489994
	WAM T133131	Male	WA, West Turner Syncline, 18 km W. of Tom Price	OK272555
	WAM T133132	Male	WA, West Turner Syncline, 18 km W. of Tom Price	OK272556
	WAM T133133	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK489995
	WAM T133135	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK272557
	WAM T133137	Female	WA, 64 km NW. of Newman	OK272558
	WAM T133138	Male	WA, West Turner Syncline, 28 km W. of Tom Price	OK272559
	WAM T133139	Female	WA, West Turner Syncline, 28 km W. of Tom Price	OK272560
	WAM T133140	Male	WA, West Turner Syncline, 28 km W. of Tom Price	OK272561
	WAM T133142	Female	WA, West Turner Syncline, 28 km W. of Tom Price	OK272562
	WAM T133143	Male	WA, West Turner Syncline, 28 km W. of Tom Price	OK272563
	WAM T133144	Male	WA, West Turner Syncline, 28 km W. of Tom Price	OK272564

Species	Registration No.	Sex and type status	Locality	GenBank No.
	WAM T133145	Male	WA, 114.4 km NW. of Newman	OK272565
	WAM T133146	Tritonymph	WA, 114.4 km NW. of Newman	OK272566
	WAM T133147	Tritonymph	WA, 114.4 km NW. of Newman	OK272567
	WAM T133154	Male	WA, BlueSpec, 18 km NE. of Nullagine	OK272568
	WAM T133155	Male	WA, BlueSpec, 18 km NE. of Nullagine	OK489996
	WAM T133156	Male	WA, BlueSpec, 18 km NE. of Nullagine	OK489997
	WAM T133157	Protonymph	WA, Nammuldi-Silvergrass, 53.6 km NW. of Tom Price	OK489998
	WAM T133158	Male	WA, 52.4 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK489999
	WAM T133170	Female	WA, Area C, 27.2 km NE. of Tom Price	OK272569
	WAM T133172	Male	WA, Area C, 86.2 km NW. of Newman	OK272570
	WAM T133173	Male	WA, West Turner Syncline, 18 km W. of Tom Price	OK272571
	WAM T133174	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK272572
	WAM T133175	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK272573
	WAM T133176	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK272574
	WAM T133177	Female	WA, West Turner Syncline, 18 km W. of Tom Price	OK490000
	WAM T133178	Male	WA, West Turner Syncline, 31 km WSW. of Tom Price	OK272575
	WAM T133179	Male	WA, West Turner Syncline, 31 km WSW. of Tom Price	OK272576
	WAM T133182	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK490001
	WAM T133183	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272577
	WAM T133184	Deutonymph	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272578
	WAM T133185	Deutonymph	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272579
	WAM T133186	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272580
	WAM T133187	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272581
	WAM T133188	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272582
	WAM T133189	Female	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272583
	WAM T133190	Male	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272584

Species	Registration No.	Sex and type status	Locality	GenBank No.
	WAM T133191	Male	WA, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price	OK272585
	WAM T133192	Female	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK272586
	WAM T133193	Male	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK272587
	WAM T133194	Female	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK490002
	WAM T133408	Female	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK272588
	WAM T133409	Male	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK490003
	WAM T133410	Male	WA, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price	OK272589
	WAM T133411	Male	WA, Nammuldi-Silvergrass, 53.6 km NW. of Tom Price	OK272590
	WAM T133413	Male	WA, Area C, 86.2 km NW. of Newman	OK272591
	WAM T133414	Female	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK272592
	WAM T133415	Male	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK272593
	WAM T133416	Tritonymph	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK272594
	WAM T133418	Female	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK272595
	WAM T133419	Female	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK255295
	WAM T133420	Female	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235424
	WAM T133421	Female	WA, 52.2 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235425
	WAM T133423	Male	WA, 52.4 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235426
	WAM T133424	Male	WA, 52.4 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235427
	WAM T133425	Male	WA, 52.4 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235428
	WAM T133426	Male	WA, 50.7 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235429
	WAM T133429	Protonymph	WA, 50.7 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235430
	WAM T133430	Female	WA, 50.7 km W. of Pannawonica, Mesa G (Warramboo Lease)	OK235431
	WAM T133432	Male	WA, Area C, 22.7 km NE. of Tom Price	OK235432
	WAM T133433	Female	WA, Hope Downs, 74 km NW. of Newman	OK235433

Family Garypidae Simon, 1879

Subfamily Synsphyroninae Beier, 1932

Genus *Synsphyronus* Chamberlin, 1930

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Synsphyronus Chamberlin 1930: 616.

Maorigarypus Chamberlin 1930: 617 (synonymised by Chamberlin 1943: 488).

Idiogarypus Chamberlin 1943: 499 (synonymised by Morris 1948: 37).

TYPE SPECIES

Synsphyronus: *Synsphyronus paradoxus* Chamberlin, 1930, by original designation.

Maorigarypus: *Maorigarypus melanochelatus* Chamberlin, 1930, by original designation.

Idiogarypus: *Garypus hansenii* With, 1908, by original designation.

REMARKS

Harvey et al. (2020) have recently treated a variety of garypid genera, including *Synsphyronus*, as members of the subfamily Synsphyroninae. The majority of the synsphyronine genera occur in Africa and Madagascar, although *Anagarypus* Chamberlin, 1930 also occurs in northern Australia and various regions adjacent to the Indian Ocean. *Synsphyronus* is endemic to Australia, New Zealand and New Caledonia.

Most of the new species described below have only ever been collected at a single location, despite considerable collecting effort during each of the BushBlitz expeditions. Due to their extremely small distributions, usually single outcrops or rock formations, they are short-range endemic species sensu (Harvey 2002) and may require conservation management. We note though that sampling bias may affect this assessment to some degree.

Synsphyronus codyi sp. nov.

Figures 1–10

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MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♀, Cane River Conservation Park, Cattle Pool, site CR13, 21°59'19.3"S, 115°34'13.5"E, 24 June 2011, under bark of *Melaleuca argentea*, J.M. Waldock (WAM T115044).

Paratypes

Australia: ***Western Australia:*** 3 ♀, collected with holotype (WAM T140359, T140360, T140361); 2 tritonymphs, 1 deutonymph, collected with holotype (WAM T140362–T140364).

DIAGNOSIS

Synsphyronus codyi differs from most other species of the genus by the combined presence of fused metatarsi and tarsi (Figure 9), and eight trichobothria on the fixed chelal finger and three trichobothria on the movable finger (Figure 4). The other species of *Synsphyronus* with this character combination are *S. ejuncidus* Harvey 1987, from Western Australia and South Australia, *S. hadronennus* Harvey, 1987 and *S. sertus* sp. nov. from the Northern Territory, and *S. meganennus* Harvey, 1987 from New South Wales from which it differs by the broad anterior eye (constricted in *S. hadronennus* and *S. meganennus*), *st* slightly closer to *b* than to *t* (much closer to *b* than *t* in *S. ejuncidus*) and the chelal hand (without pedicel) 1.72–1.83 × (♀) longer than broad (2.41–2.73 (♂), 2.09–2.53 (♀) × longer than broad in *S. sertus*).

DESCRIPTION

Adults

Female only. Colour (Figures 1–3) of sclerotised portions generally yellow-brown; tergites II–X with paired darker patches. Epicuticle waxy. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 17 blades; lamina exterior present.

Pedipalp (Figure 8): trochanter 1.64, femur 3.67–4.70, patella 2.46–3.00, chela (with pedicel) 3.53–3.70, chela (without pedicel) 3.34–3.51, hand (without pedicel) 1.72–1.83 × longer than broad, movable finger 0.85–0.97 × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 3 trichobothria (Figure 4): *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* subdistally, well posterior to *et*; *st* situated slightly closer to *b* than *t*; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 5); fixed finger with 37 teeth; movable finger with 31 teeth; accessory teeth absent.

Carapace (Figure 3): 0.91 × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 10) situated c. one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 5 near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 3 apical acuminate setae, plus 5 additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: 4: 4: 5: 11.

Legs (Figure 9): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.74 × longer than broad; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

Abdomen: tergites II–X and sternites V–X with median suture line (Figures 1, 2). Tergal chaetotaxy: 4: 4: 6: 6: 6: 8: 6: 6: 6: 4: 2: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: 6: (0) 7 (0): (0) 8 (0): 8: 8: 9: 10: 9: 7: 4: 2; uniseriate; all setae quadricarinate except for setae on sternites II–IV and medial setae on sternites V–VI, which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.

Dimensions: holotype (WAM T115044) followed by 3 other females (when measured): Body length 4.09 (2.98–3.21). Pedipalps: trochanter 0.475/0.290, femur 1.060/0.250 (0.770–1.080/0.210–0.230), patella 0.770/0.285 (0.590–0.780/0.240–0.260), chela (with pedicel) 1.500/0.420 (1.200–1.500/0.340–0.405), chela (without pedicel) 1.410 (1.160–1.420), hand (without pedicel) length 0.770 (0.590–0.740), movable finger length 0.655 (0.575–0.680). Carapace 0.930/1.02; eye diameter, anterior 0.050, posterior 0.075. Leg IV: femur + patella 0.785/0.21, tibia 0.540/0.120, tarsus 0.360/0.095.

Tritonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.38, femur 4.10, patella 2.40, chela (with pedicel) 3.54, chela (without pedicel) 3.34, hand (without pedicel) 1.77 × longer than broad, and movable finger 0.94 × longer than hand (without pedicel). Fixed chelal finger with 7 trichobothria, movable chelal finger with 2 trichobothria (Figure 6): *eb*, *esb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* subdistally.

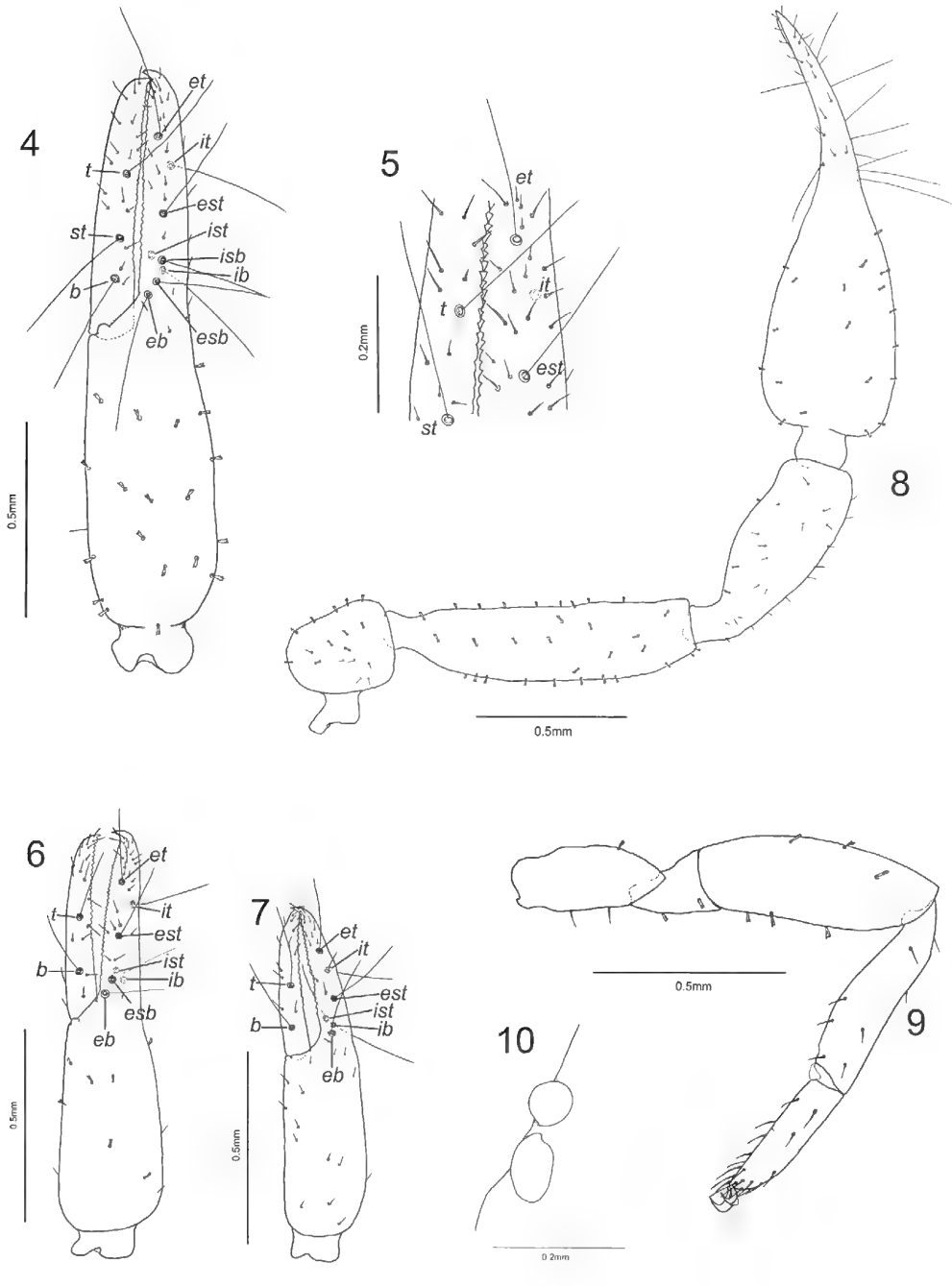
Carapace: 0.82 × longer than broad; with 4 setae near posterior margin.

Legs: much as in adults.

Abdomen: tergal chaetotaxy: 4: 4: 4: 6: 6: 7: 7: 8: 8: 6: 4: 2. Sternal chaetotaxy: 2: (0) 4 (0): (0) 4 (0): 6: 6: 6: 6: 6: 4: 2: 2.

Dimensions: WAM T140362: Body length 2.62. Pedipalps: trochanter 0.360/0.260, femur 0.800/0.195, patella 0.540/0.225, chela (with pedicel) 1.080/0.305, chela (without pedicel) 1.020, hand (without pedicel) length 0.540, movable finger length 0.510. Carapace 0.735/0.900.

FIGURES 1–3 *Synsphyronus codyi* sp. nov., holotype ♀ (WAM T115044): 1) body, dorsal; 2) body, ventral; 3) cephalothorax, dorsal.



FIGURES 4–10 *Synsphyronus codyi* sp. nov., holotype ♀ (WAM T115044), unless stated otherwise: 4) left chela, retrolateral; 5) detail of chelal teeth, retrolateral; 6) left chela, retrolateral, tritonymph paratype (WAM T140362); 7) left chela, retrolateral, deutonymph paratype (WAM T140364); 8) right pedipalp, dorsal; 9) left leg IV, retrolateral; 10) left eyes, dorsal.

Deutonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.55, femur 3.73, patella 2.00, chela (with pedicel) 3.45, chela (without pedicel) 3.26, hand (without pedicel) 1.65 × longer than broad, and movable finger 0.95 × longer than hand (without pedicel). Fixed chelal finger with 6 trichobothria, movable chelal finger with 2 trichobothria (Figure 7): *eb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* subdistally.

Carapace: 0.82 × longer than broad; with 4 setae near posterior margin.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 4: 4: 4: 4: 6: 6: 6: 6: 6: 6: 4: 2. Sternal chaetotaxy: 2: (0) 2 (0): (0) 2 (0): 2: 2: 4: 6: 6: 4: 2: 2.

Dimensions: WAM T140364: Body length 1.73. Pedipalps: trochanter 0.295/0.190, femur 0.560/0.150, patella 0.360/0.180, chela (with pedicel) 0.880/0.255, chela (without pedicel) 0.830, hand (without pedicel) length 0.420, movable finger length 0.400. Carapace 0.590/0.720.

REMARKS

Synsphyronus codyi has been collected from under bark of the silver cajuput, *Melaleuca argentea*, in Cane River Conservation Park, in the southwestern Pilbara region of Western Australia. This tree species occurs in northern Australia and most commonly found along river courses or near swamps (Western Australian Herbarium 1998–2021).

ETYMOLOGY

This species is named for the senior authors' son Cody Cullen.

***Synsphyronus marinae* sp. nov.**

Figures 11–22

urn:lsid:zoobank.org:act:837F3243-D7B5-4C4D-9906-40F387BFD602

MATERIAL EXAMINED

Holotype

Australia: ***Northern Territory:*** ♂, Wongalara Wildlife Sanctuary, Herbert Bluff, 14°04'12"S, 134°26'29"E, 103 m, 28 May 2012, under sandstone rocks, M.S. Harvey (NTM A005320).

Paratypes

Australia: ***Northern Territory:*** 3 ♂, 3 ♀, 1 deutonymph, collected with holotype (NTM A005321–A005327); 2 ♂, 2 ♀, collected with holotype (WAM T124416, T124420, T140373–140374).

DIAGNOSIS

Synsphyronus marinae differs from all but one species of the genus by the combined presence of fused metatarsi and tarsi (Figure 21), eight trichobothria on the fixed chelal finger, and two trichobothria on the movable finger (Figure 17). The only other species of *Synsphyronus* with this character combination is *S. heptatrichus* Harvey, 1987, from the Northern Territory which it differs by the broad anterior eye (Figure 22) (constricted in *S. heptatrichus*), the long cylindrical chelal hand (Figure 17) (shorter and basally broadened in *S. heptatrichus*), and the larger size, e.g. pedipalpal chela (with pedicel) 1.40 (♂), 1.60 (♀) in *S. marinae*, but 1.10–1.165 (♂), 1.23 (♀) in *S. heptatrichus*.

DESCRIPTION

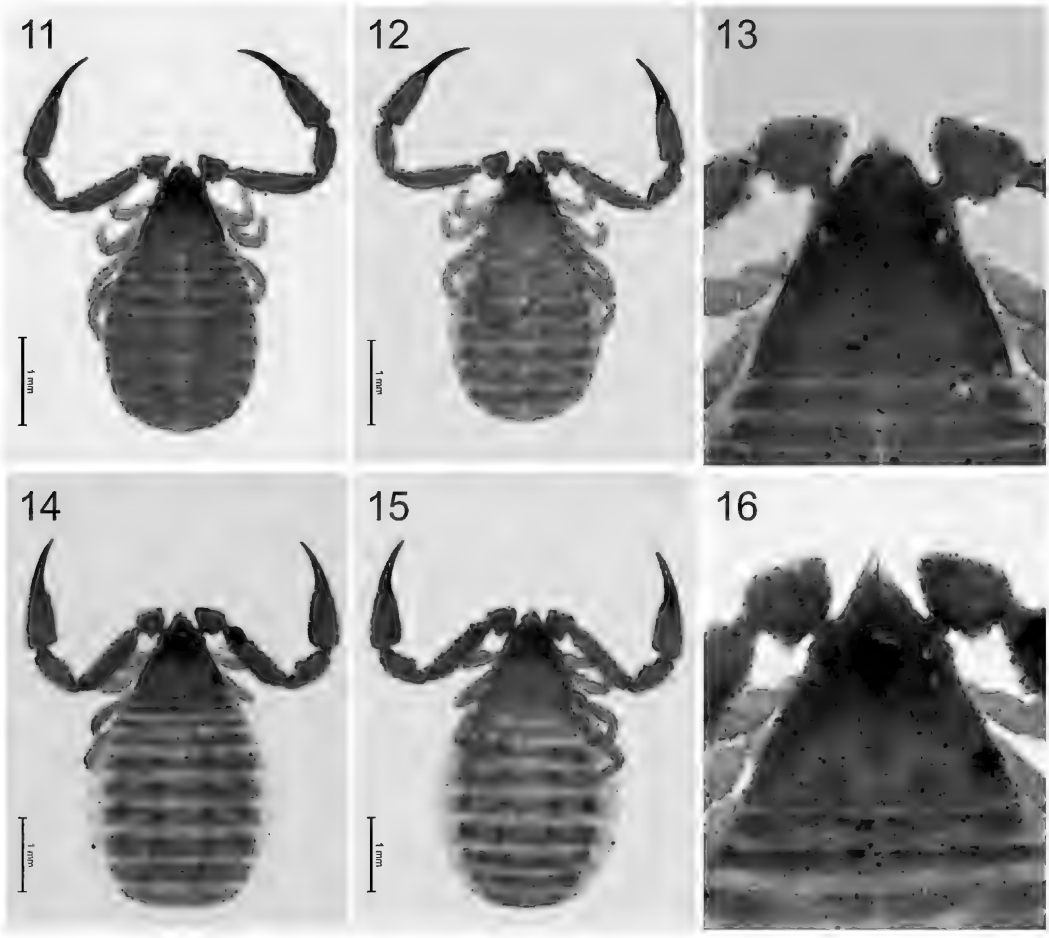
Adults

Colour (Figures 11–16) of sclerotised portions generally red-brown; tergites IV–X with paired darker patches. Epicuticle waxy. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 20 (♂), 21 (♀) blades; lamina exterior present.

Pedipalp (Figure 20): trochanter 1.23 (♂), 1.06 (♀), femur 4.08–4.55 (♂), 3.93–4.33 (♀), patella 2.73–3.17 (♂), 2.70–3.00 (♀), chela (with pedicel) 4.35–4.67 (♂), 4.05–4.11 (♀), chela (without pedicel) 4.13–4.40 (♂), 3.80–3.97 (♀), hand (without pedicel) 2.05–2.22 (♂), 1.96–2.00 (♀) × longer than broad, movable finger 0.97–1.03 (♂), 1.00 (♀) × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 2 trichobothria (Figure 17): *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* subdistally, well posterior to *et*; *st* absent; *b* situated subbasally; *t* situated subdistally; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 18); fixed finger with 38 (♂), 42 (♀) teeth; movable finger with 30 (♂), 32 (♀) teeth; accessory teeth absent.

Carapace (Figures 13, 16): 0.85 (♂), 0.76 (♀) × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 22) situated c. one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 4 near posterior margin; with numerous lyrifissures; without furrows.



FIGURES 11–16 *Synsphyronus marinae* sp. nov., holotype ♂ (NTM A005320): 11) body, dorsal; 12) body, ventral; 13) cephalothorax, dorsal. Paratype ♀ (NTM A005324): 14) body, dorsal; 15) body, ventral; 16) cephalothorax, dorsal.

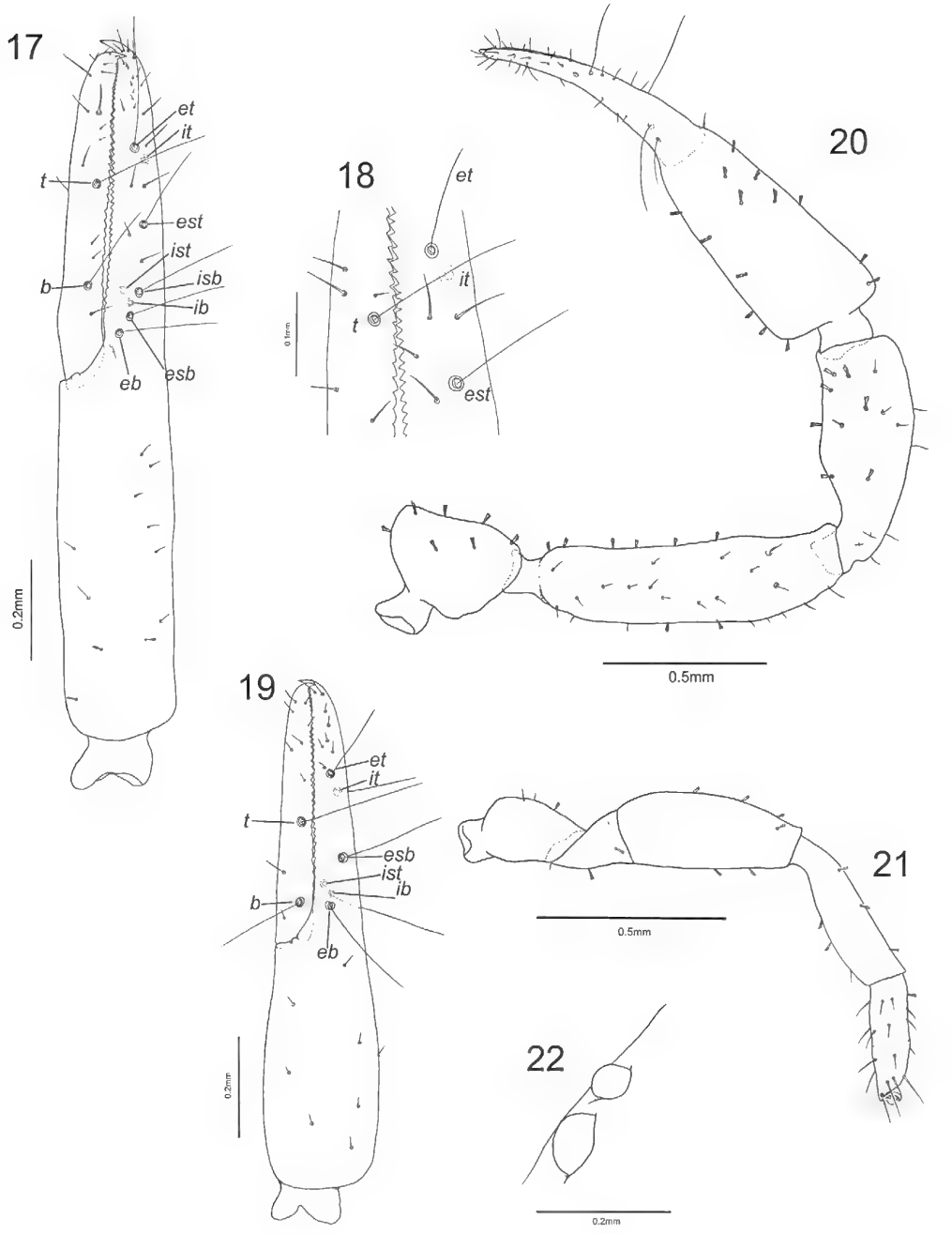
Coxal region: manducatory process rounded, with 3 apical acuminate setae, plus 5 (♂, ♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 2: 2: 3: 3; ♀, 3: 3: 3: 5.

Legs (Figure 21): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.43 (♂), 3.59 (♀) × longer than deep; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

Abdomen: tergites II–XI (♂), III–V (♀) and sternites V–X with median suture line, some only partially divided (Figures 11, 12, 14, 15). Tergal chaetotaxy: ♂, 4: 4: 4: 4: 4: 5: 4: 4: 4: 4: 2: 2; ♀, 4: 5: 5: 4: 5: 6: 6: 6: 6: 4: 2: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 5: (0) 5 [2 + 2] (0): (0) 4 (0): 4: 4: 4: 4: 4: 4: 4: 3; ♀, 8: (0) 6 (0): (0) 6 (0): 8: 8: 7: 6: 6: 4: 4: 2; uniseriate; all setae quadricarinate except for medial setae on sternites II–III (♂) and setae on sternites II–IV (♀), which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia ♂: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Genitalia ♀: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.



FIGURES 17–22 *Synsphyronus marinae* sp. nov., holotype ♂ (NTM A005320), unless stated otherwise: 17) left chela, retrolateral; 18) detail of chelal teeth, retrolateral; 19) left chela, retrolateral, deutonymph paratype (NTM A005326); 20) right pedipalp, dorsal; 21) left leg IV, retrolateral; 22) left eyes, dorsal.

Dimensions ♂: holotype (NTM A005320) followed by 5 other males (when measured): Body length 3.30 (2.89–3.23). Pedipalps: trochanter 0.450/0.365, femur 1.020/0.235 (0.980–1.040/0.220–0.240), patella 0.710/0.240 (0.710–0.730/0.230–0.240), chela (with pedicel) 1.400/0.320 (1.370–1.460/0.300–0.320), chela (without pedicel) 1.320 (1.300–1.400), hand (without pedicel) length 0.665 (0.645–0.710), movable finger length 0.685 (0.650–0.690). Carapace 0.870/1.020; eye diameter, anterior 0.060, posterior 0.080. Leg IV: femur + patella 0.685/0.200, tibia 0.450/0.110, tarsus 0.300/0.090.

Dimensions ♀: paratype (NTM A005324) followed by 2 other females (when measured): Body length 4.36 (3.76–3.94). Pedipalps: trochanter 0.350/0.330, femur 1.060/0.270 (1.040–1.060/0.240–0.250), patella 0.770/0.285 (0.750–0.780/0.260–0.265), chela (with pedicel) 1.600/0.395 (1.500–1.520/0.365–0.370), chela (without pedicel) 1.500 (1.45–1.46), hand (without pedicel) length 0.780 (0.725–0.730), movable finger length 0.780 (0.730). Carapace 0.980/1.290; eye diameter, anterior 0.070, posterior 0.090. Leg IV: femur + patella 0.790/0.220, tibia 0.505/0.130, tarsus 0.340/0.100.

Deutonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.30, femur 3.78, patella 2.24, chela (with pedicel) 4.07, chela (without pedicel) 3.81, hand (without pedicel) 1.85 × longer than broad, and movable finger 1.11 × longer than hand (without pedicel). Fixed chelal finger with 6 trichobothria, movable chelal finger with 2 trichobothria (Figure 19): *eb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* submedially.

Carapace: 0.77 × longer than broad; with 4 setae near anterior margin and 4 near posterior margin.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 4: 4: 4: 4: 4: 4: 6: 6: 6: 6: 2: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 2: 2: 4: 5:4: 4: 2: 2.

Dimensions: NTM A005326: Body length 2.52. Pedipalps: trochanter 0.300/0.230, femur 0.680/0.180, patella 0.460/0.205, chela (with pedicel) 1.080/0.265, chela (without pedicel) 1.01, hand (without pedicel) length 0.490, movable finger length 0.545. Carapace 0.675/0.880.

MOLECULAR DATA

A single specimen of this species (WAM T124420) was successfully sequenced for COI, and accessioned in GenBank under Accession No. MZ920049 (Table 1).

REMARKS

The specimens of *Synsphyronus marinae* were collected from under rocks on a sandstone bluff in Wongalara Wildlife Sanctuary, southern Arnhem Land, Northern Territory.

ETYMOLOGY

This species is named for Marina Cheng in appreciation of her companionship during several BushBlitz expeditions and her research on Hemiptera.

***Synsphyronus patricki* sp. nov.**

Figures 23–35

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MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Giralia Bay Station, N. of Centipede Well, 22°35'S, 114°17'E, 29 June 2006, under limestone rocks, P. Cullen, K.L. Edward (WAM T147102).

Paratype

Australia: ***Western Australia:*** 1 ♀, collected with holotype (WAM T76962).

DIAGNOSIS

Synsphyronus patricki resembles many other species of the genus by having separate metatarsi and tarsi (Figure 33), and eight trichobothria on the fixed chelal finger and three trichobothria on the movable finger (Figure 30). The other species of *Synsphyronus* with

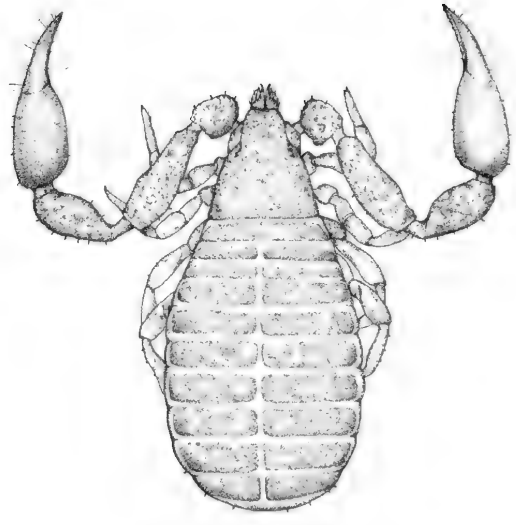
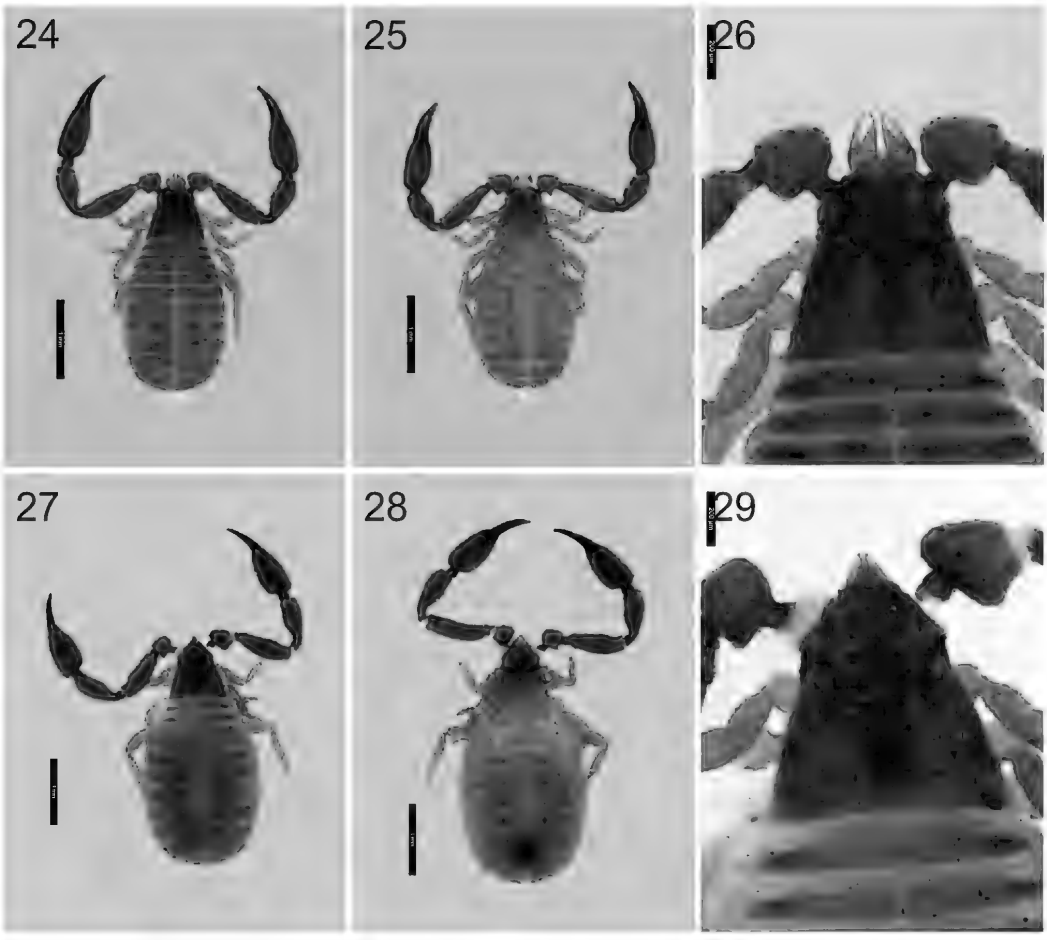


FIGURE 23 *Synsphyronus patricki* sp. nov., holotype ♂ (WAM T147102).



FIGURES 24–29 *Synsphyronus patricki* sp. nov., holotype ♂ (WAM T147102): 24) body, dorsal; 25) body, ventral; 26) cephalothorax, dorsal. Paratype ♀ (WAM T76962): 27) body, dorsal; 28) body, ventral; 29) cephalothorax, dorsal.

this character combination are *S. absitus* Harvey, 1987, *S. amplissimus* Harvey, 1987, *S. apimelus* Harvey, 1987, *S. attiguus* Harvey, 1987, *S. bounites* Harvey, 1987, *S. christopherdarwini* Harvey, 1987, *S. samueli* sp. nov., *S. dewae* Beier, 1969, *S. dorothyae* Harvey, 1987, *S. gigas* Beier, 1971, *S. gracilis* Harvey, 1987, *S. gurdoni* Harvey, Abrams & Burger, 2015, *S. hansenii* With, 1908, *S. mimulus* Chamberlin, 1943, *S. platnicki* Harvey, 2020, and *S. silveirai* Harvey, 1987. Of these species it most closely resembles *S. gurdoni* from Barrow Island, Western Australia as the rallum of both species has the middle and basal blades highly reduced (Figure 35). It differs from *S. gurdoni* by the position of trichobothrium *st* which is noticeably closer to *b* than to *t* in *S. patricki* (Figure 30), but is midway between *b* and *t* in *S. gurdoni*.

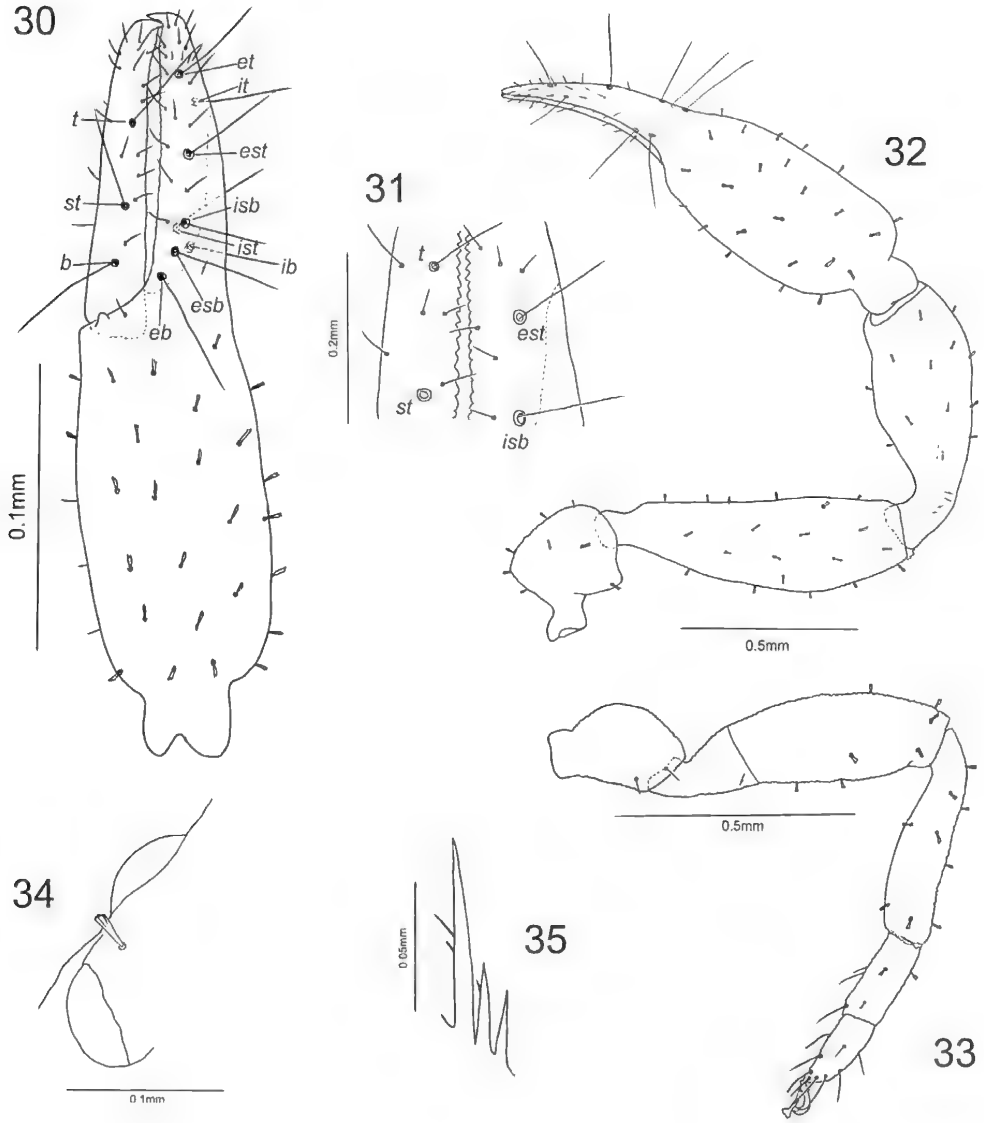
DESCRIPTION

Adults

Colour (Figures 24–29) of sclerotised portions generally red-brown; tergites IV–X with paired darker patches. Epicuticle waxy. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea unbranched; rallum of 3 blades, the most distal blade with 2 spinules on leading edge, middle blade with 1 spinule, basal blade smooth, middle and basal blades very short (Figure 35); serrula exterior with 17 (♂), 19 (♀) blades; lamina exterior present.

Pedipalp (Figure 32): trochanter 1.25 (♂), 1.31 (♀), femur 3.26 (♂), 3.41 (♀), patella 2.39 (♂), 2.75 (♀), chela (with pedicel) 3.74 (♂), 3.43 (♀), chela (without pedicel) 3.43 (♂), 3.20 (♀), hand (without pedicel) 1.87 (♂), 1.71 (♀) × longer than broad, movable finger 0.85 (♂), 0.91 (♀) × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 3 trichobothria (Figure 30); *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* subdistally, well posterior to *et*; *b* situated subbasally; *st* situated submedially, slightly closer to *b* than to *t*; *t* situated subdistally; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in



FIGURES 30–35 *Synsphyronus patricki* sp. nov., holotype ♂ (WAM T147102), unless stated otherwise: 30) left chela, retrolateral; 31) detail of chelal teeth, retrolateral; 32) right pedipalp, dorsal; 33) left leg IV, retrolateral; 34) left eyes, dorsal; 35) left rallum, lateral, paratype ♀ (WAM T76962).

fixed finger and near *t* in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 31); fixed finger with 40 (♂, ♀) teeth; movable finger with 34 (♂, ♀) teeth; accessory teeth absent.

Carapace (Figures 26, 29): 0.85 (♂), 0.89 (♀) × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of large corneate eyes (Figure 34) situated c. one-third carapace length from anterior margin; anterior eye broad; with 5 (♂), 4 (♀) setae near anterior margin and 4 near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 3 apical acuminate setae, plus 5 (♂, ♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 2; 2; 2; 4; ♀, 2; 2; 2; 3; 4.

Legs (Figure 33): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.67 (♂), 3.88 (♀) × longer than deep; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

Abdomen: tergites II–X (♂, ♀) and sternites IV–X (♂), V–X (♀) with median suture line (Figures 24–25, 27–28). Tergal chaetotaxy: ♂, 4: 4: 4: 4: 4: 5: 4: 4: 4: 4: 2: 2; ♀, 4: 4: 5: 4: 4: 4: 4: 4: 4: 4: 2: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 6: (0) 3 [4 + 4] (0): (0) 2 (0): 4: 2: 3: 2: 5: 4: 4: 2; ♀, 4: (0) 7 (0): (0) 5 (0): 4: 3: 5: 6: 6: 6: 4: 2; uniseriate; all setae quadricarinate except for setae on sternites II–III, and medial setae on segments V–VI (♂) and setae on sternites II–IV (♀), which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia ♂: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Genitalia ♀: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.

Dimensions ♂: holotype (WAM T147102): Body length 2.90. Pedipalps: trochanter 0.390/0.315, femur 0.880/0.270, patella 0.740/0.270, chela (with pedicel) 1.31/0.350, chela (without pedicel) 1.20, hand (without pedicel) length 0.655, movable finger length 0.555. Carapace 0.655/0.770; eye diameter, anterior 0.075, posterior 0.070. Leg IV: femur + patella 0.660/0.180, tibia 0.460/0.105, metatarsus 0.190/0.075, tarsus 0.175/0.070.

Dimensions ♀: paratype (WAM T76962): Body length 3.76. Pedipalps: trochanter 0.420/0.320, femur 0.990/0.290, patella 0.825/0.300, chela (with pedicel) 1.440/0.420, chela (without pedicel) 1.345, hand (without pedicel) length 0.720, movable finger length 0.655. Carapace 0.830/0.930; eye diameter, anterior 0.065, posterior 0.090. Leg IV: femur + patella 0.795/0.205, tibia 0.520/0.115, metatarsus 0.225/0.090, tarsus 0.210/0.075.

REMARKS

The specimens of *Synsphyronus patricki* were collected from under limestone rocks near Centipede Well, Carnarvon bioregion, Western Australia. The vegetation at the site is dominated by *Triodia* sp. with sparse *Acacia*.

ETYMOLOGY

This species is named in honour of Patrick Cullen, the collector of the type specimens and many other interesting short-range endemics throughout the Pilbara and Carnarvon regions.

Synsphyronus pharangites **sp. nov.**

Figures 36–46

urn:lsid:zoobank.org:act:FDCAD1DB-6EDB-49CC-A890-60C174EC57E9

MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Cape Range, Shothole Canyon Road, 22°02'43.40"S, 114°01'52.97"E, 22 June 2019, under bark of *Corymbia hamersleyana*, M.S. Harvey (WAM T148101).

Paratypes

Australia: ***Western Australia:*** 3 ♀, Cape Range, Shothole Canyon Road, 22°02'43.40"S, 114°01'52.97"E, 22 June 2019, under bark of *Corymbia hamersleyana*, M.S. Harvey (WAM T148098–148100).

DIAGNOSIS

Synsphyronus pharangites differs from most other species of the genus by the combined presence of fused metatarsi and tarsi (Figure 45), seven trichobothria on the fixed chelal finger, and one trichobothrium on the movable finger (Figure 42). The only other species of *Synsphyronus* with this character combination is *S. callus* Hoff, 1947, from southern Western Australia, which it differs by the straight pedipalpal femur (Figure 44) (slightly procurved in *S. callus*), the broadened chelal hand (Figure 44) (cylindrical in *S. callus*), and the position of trichobothria *et* and *it*, which are more basally situated than in *S. callus* (Figure 42).

DESCRIPTION

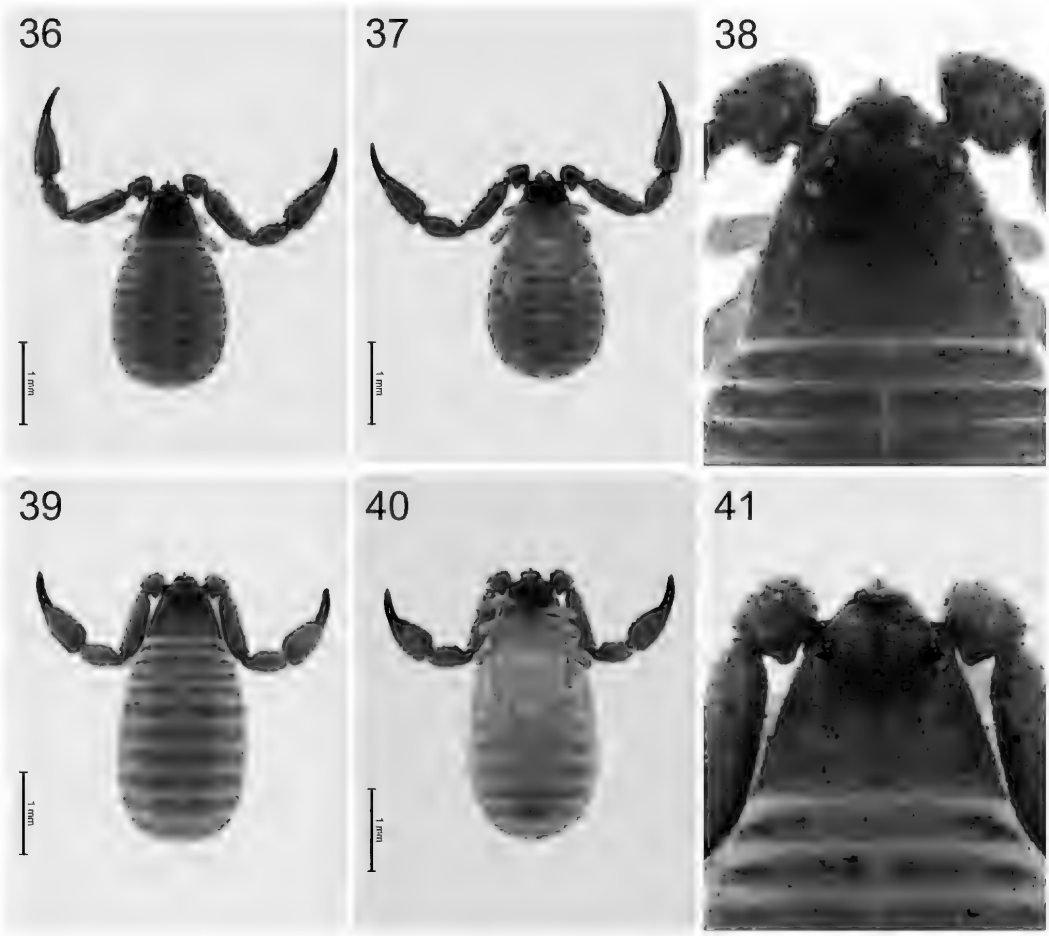
Adults

Colour (Figures 36–41) of sclerotised portions generally red-brown; tergites II–X with paired darker patches. Epicuticle waxy. Setae generally aligned

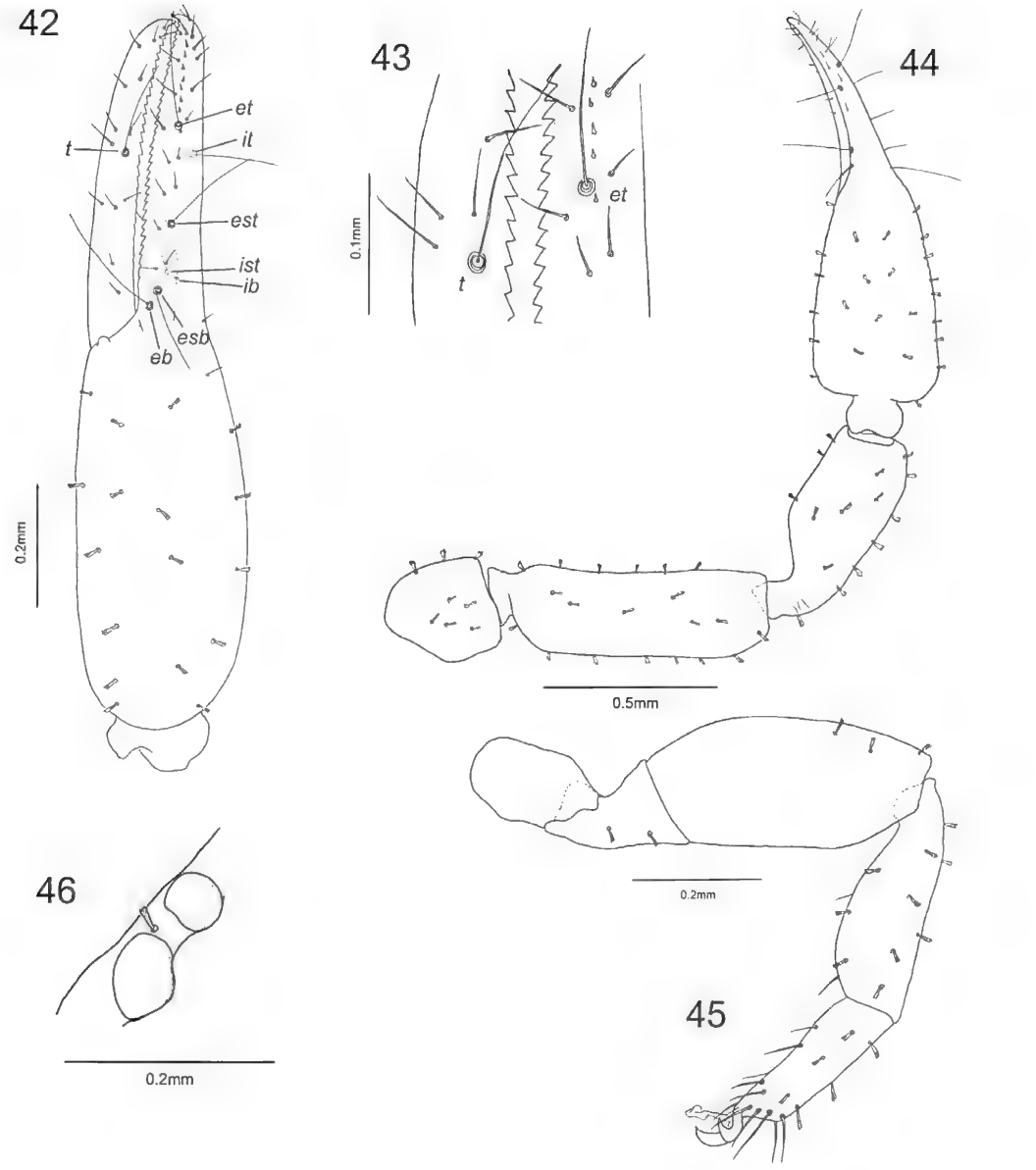
perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea of ♂ and ♀ unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 18 blades; lamina exterior present.

Pedipalp (Figure 44): trochanter 1.55 (♂), 1.22–1.29 (♀), femur 3.14 (♂), 3.42–3.58 (♀), patella 2.56 (♂), 2.18–2.48 (♀), chela (with pedicel) 3.97 (♂), 3.47–3.62 (♀), chela (without pedicel) 3.74 (♂), 3.29–3.36 (♀), hand (without pedicel) 1.97 (♂), 1.67–1.84 (♀) × longer than broad, moveable finger 0.92 (♂), 0.80–0.94 (♀) × longer hand (without pedicel). Fixed chelal finger with 7 trichobothria, movable chelal finger with 1 trichobothrium (Figure 42): *eb* and *esb* situated basally, *isb* absent, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* submedially, well posterior to *et*; *b* and *st* absent; *t* situated subdistally; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 43); fixed finger with 33 (♂), 37 (♀) teeth; movable finger with 26 (♂), 28 (♀) teeth; accessory teeth absent.



FIGURES 36–41 *Synsphyronus pharangites*, sp. nov., holotype ♂ (WAM T148101): 36) body, dorsal; 37) body, ventral; 38) cephalothorax, dorsal. Paratype ♀ (WAM T148098): 39) body, dorsal; 40) body, ventral; 41) cephalothorax, dorsal.



FIGURES 42–46 *Synsphyronus pharangites* sp. nov., holotype ♂ (WAM T148101): 42) left chela, retrolateral; 43) detail of chelal teeth, retrolateral; 44) right pedipalp, dorsal; 45) left leg IV, retrolateral; 46) left eyes, dorsal.

Carapace (Figures 38, 41): 0.82 (♂, ♀) × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 46) situated c. one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 6 near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 2 apical acuminate setae, plus 6 (♂, ♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 3: 4: 5: 5; ♀, 4: 5: 7: 9.

Legs (Figure 45): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate;

femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.05 (♂), 3.07 (♀) × longer than deep; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

Abdomen: tergites II–X (♂), II–VI (♀) and sternites V–X with median suture line, some only partially divided (Figures 36, 37, 39, 40). Tergal chaetotaxy: ♂, 4: 4: 4: 4: 7: 8: 8: 6: 6: 7: 2: 2; ♀, 4: 5: 5: 7: 9: 6: 6: 10: 8: 6: 4: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 7: (0) 4 [2 + 2] (0): (0) 2 (0): 4: 4: 7: 8: 7: 8: 4: 2; ♀, 7: (0) 6 (0): (0) 6 (0): 6: 8: 8: 8: 8: 6: 4: 2; uniseriate; all setae quadricarinate except for setae on sternites II–IV and medial setae on sternites V–VIII, which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia ♂: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Genitalia ♀: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.

Dimensions ♂: holotype (WAM T148101): Body length 2.72. Pedipalps: trochanter 0.410/0.265, femur 0.800/0.255, patella 0.615/0.240, chela (with pedicel) 1.210/0.305, chela (without pedicel) 1.140, hand (without pedicel) length 0.600, movable finger length 0.550. Carapace 0.720/0.880; eye diameter, anterior 0.055, posterior 0.080. Leg IV: femur + patella 0.580/0.190, tibia 0.360/0.105, tarsus 0.260/0.075.

Dimensions ♀: paratype (WAM T148098) followed by 2 other females (when measured): Body length 3.47 (2.94–3.18). Pedipalps: trochanter 0.400/0.320, femur 0.890/0.260 (0.820–0.860/0.230–0.240), patella 0.645/0.260 (0.610–0.660/0.270–0.280), chela (with pedicel) 1.300/0.375 (1.340/0.370–0.380), chela (without pedicel) 1.260 (1.220–1.260), hand (without pedicel) length 0.670 (0.630–0.700), movable finger length 0.610 (0.560–0.590). Carapace 0.760/0.930; eye diameter, anterior 0.055, posterior 0.075. Leg IV: femur + patella 0.630/0.205, tibia 0.395/0.115, tarsus 0.315/0.085.

REMARKS

Synsphyronus pharangites has only been collected from a single location in Cape Range National Park, where the specimens were collected from under the bark of *Corymbia hamersleyana*. Cape Range is situated in the Carnarvon bioregion.

ETYMOLOGY

The species epithet an adjective referring to the species occurrence in Shothole Canyon (*pharangites*, Greek, of a gully) (Brown 1956).

***Synsphyronus samueli* sp. nov.**

Figures 47–55

urn:lsid:zoobank.org:act:E0A52346-6B67-40BC-874D-827B48EE8B1C

MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Cane River Conservation Park, site CR20, mesa just below top, 22°14'43.0"S, 115°28'49.4"E, 26 June 2011, under rocks beneath fig tree, J.M. Waldock (WAM T115038).

Paratype

Australia: ***Western Australia:*** 1 deutonymph, collected with holotype (WAM T140365).

DIAGNOSIS

Synsphyronus samueli resembles many other species of the genus by having separate metatarsi and tarsi (Figure 54), eight trichobothria on the fixed chelal finger, and three trichobothria on the movable finger (Figure 50). The other species of *Synsphyronus* with this character combination are *S. absitus* Harvey, 1987, *S. amplissimus* Harvey, 1987, *S. apimelus* Harvey, 1987, *S. attiguus* Harvey, 1987, *S. bounites* Harvey, 1987, *S. christopherdarwini* Harvey, 1987, *S. dewae* Beier, 1969, *S. dorothyae* Harvey, 1987, *S. gigas* Beier, 1971, *S. gracilis* Harvey, 1987, *S. gurdoni* Harvey, Abrams & Burger, 2015, *S. hansenii* With, 1908, *S. mimulus* Chamberlin, 1943, *S. patricki*, sp. nov., *S. platnicki* Harvey, 2020, and *S. silveirai* Harvey, 1987. It differs from all of these species by the undulate dorsal and ventral margins of the chelal hand (Figure 50).

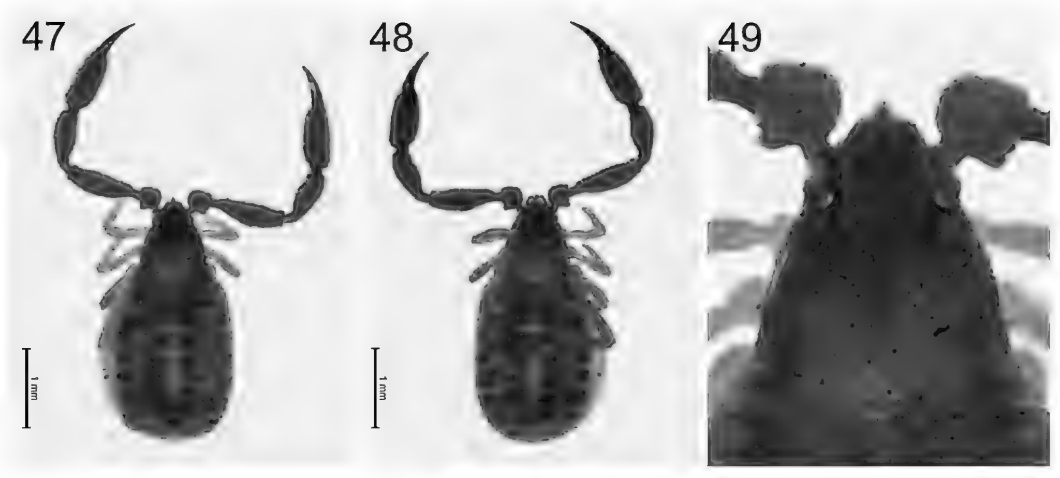
DESCRIPTION

Adults

Male only. Colour (Figures 47–49) of sclerotised portions generally red-brown; tergites II–X with paired darker patches. Epicuticle waxy. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 18 blades; lamina exterior present.

Pedipalp (Figure 53): trochanter 1.25, femur 3.49, patella 2.88, chela (with pedicel) 4.03, chela (without pedicel) 3.73, hand (without pedicel) 2.14 × longer than broad, hand (without pedicel) 1.29 × longer than movable finger. Fixed chelal finger with 8 trichobothria, movable chelal finger with 3 trichobothria (Figure 50): *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal



FIGURES 47–49 *Synsphyronus samueli* sp. nov., holotype ♂ (WAM T115038): 47) body, dorsal; 48) body, ventral; 49) cephalothorax, dorsal.

row, and *it* subdistally, well posterior to *et*; *st* situated slightly closer to *b* than to *t*; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 51); fixed finger with 38 teeth; movable finger with 27 teeth; accessory teeth absent.

Carapace (Figure 49): 0.96 × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 55) situated c. one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 5 near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 4 apical acuminate setae, plus 2 additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: 1: 2: 3: 3.

Legs (Figure 54): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 4.11 × longer than deep; metatarsi and tarsi not fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

Abdomen: tergites II–X and sternites V–X with median suture line (Figures 47, 48). Tergal chaetotaxy: ♂, 4: 4: 4: 4: 4: 4: 4: 4: 4: 4: 2: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 9: (0) 5 [5 + 5] (0): (0) 6 (0): 4: 4: 4: 4: 6: 4: 3: 3; uniseriate; all setae quadricarinate except for setae on sternites II–IV and medial setae on sternites V–VIII, which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Dimensions: holotype (WAM T115038): Body length 3.38. Pedipalps: trochanter 0.420/0.335, femur 0.995/0.285, patella 0.850/0.295, chela (with pedicel) 1.410/0.350, chela (without pedicel) 1.305, hand (without pedicel) length 0.750, movable finger length 0.580. Carapace 0.835/0.870; eye diameter, anterior 0.065, posterior 0.082. Leg IV: femur + patella 0.780/0.190, tibia 0.550/0.115, metatarsus 0.229/0.097, tarsus 0.184/0.080.

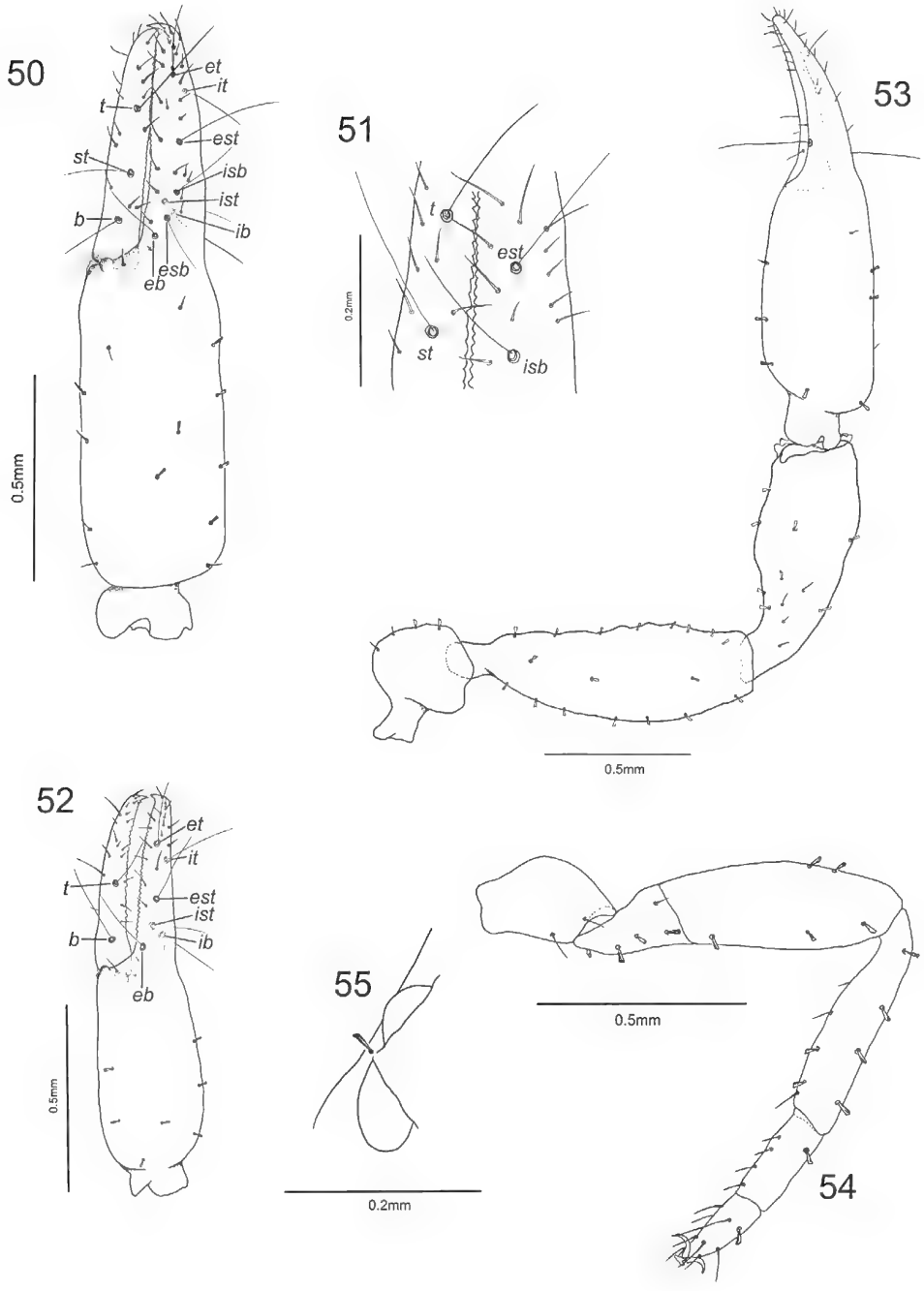
Deutonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.42, femur 3.2, patella 2.41, chela (with pedicel) 3.69, chela (without pedicel) 3.31, hand (without pedicel) 1.71 × longer than broad, and movable finger 0.949 × longer than hand (without pedicel). Fixed chelal finger with 6 trichobothria, movable chelal finger with 2 trichobothria (Figure 52): *eb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* subdistally.

Carapace: 0.85 × longer than broad; with 4 setae near anterior margin and 4 near posterior margin.



FIGURES 50–55 *Synsphyronus samueli* sp. nov., holotype ♂ (WAM T115038), unless stated otherwise: 50) left chela, retrolateral; 51) detail of chelal teeth, retrolateral; 52) left chela, retrolateral, deutonymph paratype (WAM T140365); 53) right pedipalp, dorsal; 54) left leg IV, retrolateral; 55) left eyes, dorsal.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 2: 2: 2: 2: 4: 4: 4: 4: 4: 4: 2: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 2: 2: 2: 2: 2: 2: 2: 2.

Dimensions: WAM T140365: Body length 2.35. Pedipalps: trochanter 0.305/0.215, femur 0.640/0.20, patella 0.555/0.23, chela (with pedicel) 1.07/0.290, chela (without pedicel) 0.96, hand (without pedicel) length 0.495, movable finger length 0.470. Carapace 0.660/0.775.

REMARKS

Synsphyronus samueli has been collected from Cane River Conservation Park, where the specimens were found under rocks beneath a fig tree. The Park is located in the south-western corner of the Pilbara bioregion.

ETYMOLOGY

This species is named for the senior authors' son Sam Cullen.

***Synsphyronus sertus* sp. nov.**

Figures 56–69

urn:lsid:zoobank.org:act:C6165A7F-11FB-4CAC-8CCC-524D72CBF2ED

MATERIAL EXAMINED

Holotype

Australia: ***Northern Territory:*** ♂, Henbury Station, James Range, c. 7 km WNW. of Mt Keartland, 24°01'31"S, 133°02'30"E, 592 m, 17 May 2013, under shaded sandstone rocks, south-facing gully, M.S. Harvey (NTM A005328).

Paratypes

Australia: ***Northern Territory:*** 3 ♂, 5 ♀, 6 tritonymphs, 1 deutonymph, 1 protonymph, collected with holotype (NTM A005329–A005344); 2 ♂, 2 ♀, 2 tritonymphs, 1 protonymph, collected with holotype (WAM T131644, T131645, T140375–140379).

DIAGNOSIS

Synsphyronus sertus differs from most other species of the genus by the combined presence of fused metatarsi and tarsi (Figure 68), eight trichobothria on the fixed chelal finger, and three trichobothria on the movable finger (Figure 62). The other species of *Synsphyronus* with this character combination are *S. ejuncidus* Harvey, 1987 and *S. codyi* sp. nov. from Western Australia, *S. hadronennus* Harvey, 1987 from the Northern Territory, and *S. meganennus* Harvey, 1987 from New South Wales from which it differs by the broad anterior eye (Figure 69) (constricted in *S. hadronennus* and *S. meganennus*), *st* midway between *b* and *t* (Figure 62) (much closer to *b* than *t* in *S. ejuncidus*) and the chelal hand (without pedicel) 2.41–2.73 (♂), 2.09–2.53 (♀) × longer than broad (1.72–1.83 × (♀) longer than broad in *S. codyi*).

DESCRIPTION

Adults

Colour (Figures 56–61) of sclerotised portions generally red-brown; tergites IV–X with paired darker patches. Epicuticle waxy. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

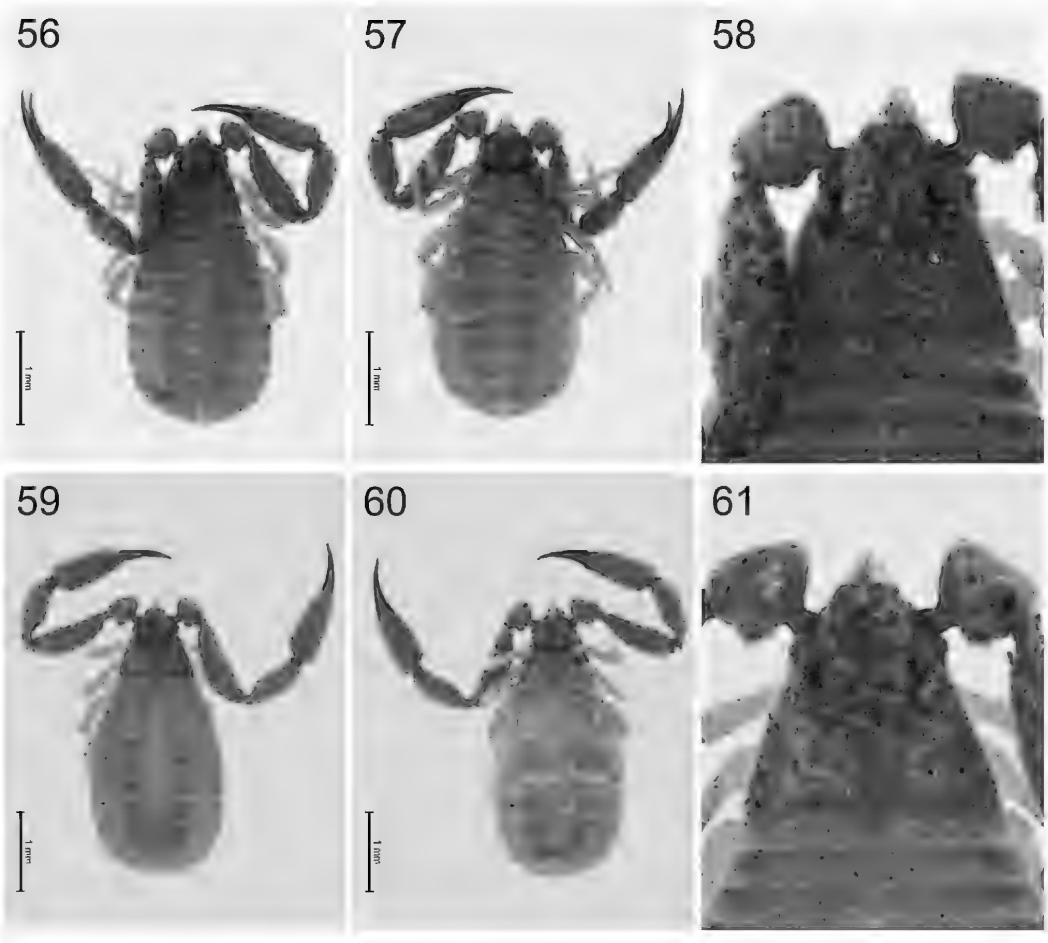
Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea of ♂ and ♀ unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 17 (♂), 18 (♀) blades; lamina exterior present.

Pedipalp (Figure 67): trochanter 1.28 (♂), 1.22 (♀), femur 3.38–4.80 (♂), 3.56–4.17 (♀), patella 2.81–3.07 (♂), 2.84–2.91 (♀), chela (with pedicel) 4.41–5.13 (♂), 3.93–4.32 (♀), chela (without pedicel) 4.11–4.69 (♂), 3.71–4.03 (♀), hand (without pedicel) 2.41–2.73 (♂), 2.09-2.53 (♀) × longer than broad, movable finger 0.68–0.74 (♂), 0.80–0.77 (♀) × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 3 trichobothria (Figure 62): *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* subdistally, well posterior to *et*; *st* situated midway between *b* and *t*; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 63); fixed finger with 32 (♂), 38 (♀) teeth; movable finger with 28 (♂), 31 (♀) teeth; accessory teeth absent.

Carapace (Figures 56, 59): 0.91 (♂), 0.90 (♀) × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 69) situated c. one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 4 near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 3 apical acuminate setae, plus 2 (♂, ♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 2: 2: 3: 3; ♀, 3: 3: 4: 9.

Legs (Figure 68): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.58 (♂), 3.80 (♀) × longer than deep; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.



FIGURES 56–61 *Synsphyronus sertus* sp. nov., holotype ♂ (NTM A005328): 56) body, dorsal; 57) body, ventral; 58) cephalothorax, dorsal. Paratype ♀ (NTM A005333): 59) body, dorsal; 60) body, ventral; 61) cephalothorax, dorsal.

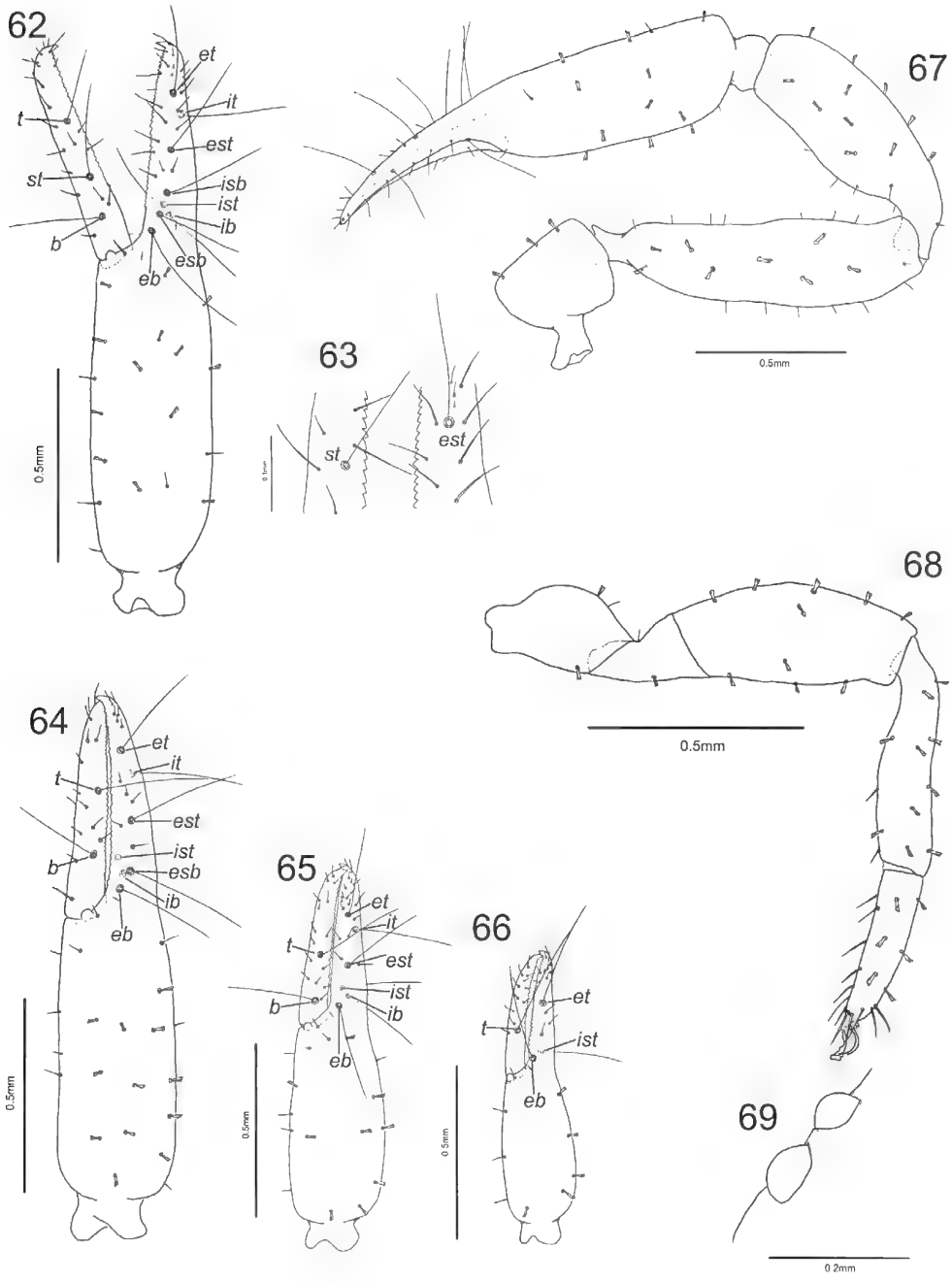
Abdomen: tergites II–X and sternites V–X with median suture line (Figures 56–57, 59–60). Tergal chaetotaxy: ♂, 2: 2: 2: 4: 4: 4: 4: 5: 6: 6: 4: 2; ♀, 5: 4: 4: 4: 4: 6: 6: 6: 6: 4: 4: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 5: (0) 4 [2 + 2] (0): (0) 5 (0): 5: 4: 4: 4: 6: 6: 4: 2; ♀, 8: (0) 5 (0): (0) 7 (0): 8: 8: 8: 8: 6: 6: 2: 2; uniseriate; all setae quadricarinate except for setae on sternites II–IV and medial setae on sternites V–VI, which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia ♂: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Genitalia ♀: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.

Dimensions ♂: holotype (NTM A005328) followed by 5 other males (when measured): Body length 3.29 (2.96–3.12). Pedipalps: trochanter 0.365/0.285, femur 1.060/0.280 (0.940–1.060/0.250–0.290), patella 0.870/0.280 (0.760–0.870/0.270–0.300), chela (with pedicel) 1.520/0.315 (1.470–1.540/0.290–0.345), chela (without pedicel) 1.420 (1.360–1.430), hand (without pedicel) length 0.820 (0.790–0.840), movable finger length 0.625 (0.540–0.610). Carapace 0.860/0.950; eye diameter, anterior 0.065, posterior 0.090. Leg IV: femur + patella 0.770/0.215, tibia 0.550/0.115, tarsus 0.370/0.085.

Dimensions ♀: paratype (NTM A005333) followed by 5 other females (when measured): Body length 3.73 (3.34–3.68). Pedipalps: trochanter 0.500/0.410,



FIGURES 62–69 *Synsphyronus sertus* sp. nov., holotype ♂ (NTM A005324), unless stated otherwise: 62) left chela, retrolateral; 63) detail of chelal teeth, retrolateral; 64) left chela, retrolateral, tritonymph paratype (NTM A005339); 65) left chela, retrolateral, deutonymph paratype (NTM A005343); 66) left chela, retrolateral, protonymph paratype (NTM A005344); 67) right pedipalp, dorsal; 68) left leg IV, retrolateral; 69) left eyes, dorsal.

femur 1.140/0.320 (1.060–1.250/0.290–0.330), patella 0.925/0.320 (0.910–0.960/0.320–0.330), chela (with pedicel) 1.610/0.410 (1.620–1.740/0.390–0.430), chela (without pedicel) 1.520 (1.510–1.640), hand (without pedicel) length 0.880 (0.830–0.950), movable finger length 0.705 (0.610–0.720). Carapace 0.940/1.040; eye diameter, anterior 0.070, posterior 0.095. Leg IV: femur + patella 0.835/0.220, tibia 0.575/0.120, tarsus 0.385/0.095.

Tritonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.21, femur 3.76, patella 2.88, chela (with pedicel) 3.79, chela (without pedicel) 3.52, hand (without pedicel) 2.02 × longer than broad, and movable finger 0.75 × longer than hand (without pedicel). Fixed chelal finger with 7 trichobothria, movable chelal finger with 2 trichobothria (Figure 64): *eb*, *esb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* subdistally.

Carapace: 0.93 × longer than broad; with 4 setae near posterior margin.

Legs: much as in adults.

Abdomen: tergal chaetotaxy: 4: 4: 4: 4: 4: 5: 6: 6: 6: 6: 4: 2. Sternal chaetotaxy: 0: (0) 4 (0): (0) 4 (0): 5: 6: 6: 6: 6: 4: 2: 2.

Dimensions: NTM A005339: Body length 3.01. Pedipalps: trochanter 0.370/0.305, femur 0.940/0.250, patella 0.720/0.250, chela (with pedicel) 1.270/0.335, chela (without pedicel) 1.180, hand (without pedicel) length 0.675, movable finger length 0.505. Carapace 0.860/0.930.

Deutonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.27, femur 3.18, patella 2.43 chela (with pedicel) 3.90, chela (without pedicel) 3.59, hand (without pedicel) 1.89 × longer than broad, and movable finger 0.91 × longer than hand (without pedicel). Fixed chelal finger with 6 trichobothria, movable chelal finger with 2 trichobothria (Figure 65): *eb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *b* subbasally; *t* subdistally.

Carapace: 0.88 × longer than broad; 4 near posterior margin.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 2: 4: 4: 2: 4: 4: 4: 6: 6: 4: 2: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 4: 4: 4: 6: 6: 4: 2: 2.

Dimensions: NTM A005343: Body length 2.32. Pedipalps: trochanter 0.330/0.260, femur 0.700/0.220, patella 0.570/0.235, chela (with pedicel) 1.130/0.290, chela (without pedicel) 1.040, hand (without pedicel) length 0.550, movable finger length 0.500. Carapace 0.715/0.810.

Protonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 4 setae on hand and 0 on movable finger; galea unbranched.

Pedipalp: trochanter 1.62, femur 3.33, patella 2.37, chela (with pedicel) 4.15, chela (without pedicel) 3.76, hand (without pedicel) 2.00 × longer than broad, and movable finger 0.88 × longer than hand (without pedicel). Fixed chelal finger with 3 trichobothria, movable chelal finger with 1 trichobothrium (Figure 65): *eb* and *ist* situated basally; *et* situated subdistally; *t* situated medially.

Carapace: 0.90 × longer than broad.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 2: 2: 2: 4: 4: 4: 4: 4: 4: 4: 4: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 2: 2: 2: 2: 2: 2: 2: 2.

Dimensions: NTM A005344: Body length 0.945. Pedipalps: trochanter 0.275/0.170, femur 0.500/0.150, patella 0.380/0.160, chela (with pedicel) 0.850/0.205, chela (without pedicel) 0.770, hand (without pedicel) length 0.410, movable finger length 0.360. Carapace 0.575/0.640.

MOLECULAR DATA

A single specimen of this species (WAM T131645) was successfully sequenced for COI, and accessioned in GenBank under Accession No. MZ934365 (Table 1).

REMARKS

The specimens of *Synsphyronus sertus* were found under sandstone rocks in a south-facing gully, with the rocks apparently shaded for much of the year. The collecting site is located in the MacDonnell Ranges bioregion in central Australia.

ETYMOLOGY

This species is named for the fused metatarsi and tarsi (*sertus*, Latin, join, knit, plait, connect) (Brown 1956).

***Synsphyronus xynus* sp. nov.**

Figures 70–83

urn:lsid:zoobank.org:act:F1561BA0-85AD-44D8-99E6-3A75A717E1F5

Synsphyronus sp. 'PSE093': Harvey et al. 2020: 37.

MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Karijini National Park, c. 20 km SW. of Hancock Gorge, 22°29'02"S, 118°08'51"E, 806 m, 15 March 2015, under eucalypt bark, M.S. Harvey et al. (WAM T135584).

Paratype

Australia: ***Western Australia:*** 1 ♀, collected with holotype (WAM T135549).

Other material

Australia: ***Western Australia:*** 1 ♂, 5 ♀, Area C West to Yandi, 101.8 km NW. of Newman, 22°38'46"S, 119°06'06"E, 12 September 2011, under bark, N. Watson (WAM T117770–117775); 2 ♂, Area C, 22.7 km NE. of Tom Price, 22°31'48"S, 117°54'46"E, 31 May 2010, under bark, D. Keirle (WAM T108732, T133432); 1 ♂, 2 ♀, Area C, 27.2 km NE. of Tom Price, 22°34'48"S, 118°01'05"E, 2 June 2010, under bark, D. Kamien (WAM T108727, T133170–T133171); 3 ♀, Area C, 27.5 km NE. of Tom Price, 22°34'48"S, 118°01'17"E, 2 June 2010, under bark, M. Menz (WAM T108744, T124675); 1 ♀, Area C, 28.4 km NE. of Tom Price, 22°33'54"S, 118°01'22"E, 1 June 2010, under bark, D. Keirle (WAM T108737); 3 ♂, Area C, 61.8 km NW. of Newman, 22°59'56"S, 118°52'09"E, 25 February 2010, under bark, Z. Hamilton (WAM T101208); 1 ♂, Area C, 78.2 km NW. of Newman, 22°55'04"S, 119°08'21"E, 18 February 2010, under bark, M. Greenham (WAM T101187); 2 tritonymphs, Area C, 82.7 km NW. of Newman, 23°00'18"S, 119°01'26"E, 21 February 2010, under bark, M. Greenham (WAM T101202); 1 ♀, Area C, 83.6 km NW. of Newman, 22°59'30"S, 118°57'32"E, 23 February 2010, under bark, M. Greenham (WAM T101174); 2 tritonymphs, Area C, 84.7 km NW. of Newman, 22°54'09"S, 119°04'15"E, 17 February 2010, under bark, Z. Hamilton (WAM T101192, T101201); 1 ♂, 3 ♀, Area C, 84.9 km NW. of Newman, 22°58'54"S, 119°00'49"E, 21 February 2010, under bark, D. Kamien (WAM T101182); 1 ♂, 1 ♀, Area C, 85.2 km NW. of Newman, 23°00'14"S, 118°59'41"E, 22 February 2010, under bark, T. Sachse (WAM T101204); 6 ♂, Area C, 86.2 km NW. of Newman, 23°00'43"S, 118°58'53"E, 22 February 2010, under bark, M. Greenham (WAM T101205, T133172, T33413); 1 ♂, 1 ♀, Area C, 88.3 km NW. of Newman, 22°56'09"S, 119°00'16"E, 20 February 2010, under bark, M. Greenham (WAM T101181); 1 ♂, Area C, 89 km NW. of Newman, 22°57'22"S, 118°58'59"E, 23 February 2010, under bark, M. Greenham (WAM T101186); 1 ♀, Area C, 89.3 km NW. of Newman, 22°54'23"S, 119°00'44"E, 19 February 2010, under bark, M. Greenham (WAM T101177); 1 ♂, Area C, 89.4 km NW. of Newman, 22°58'48"S, 118°57'43"E, 23 February 2010, under bark, D. Kamien (WAM T101203); 2 ♀, Area C, 89.5 km NW. of Newman, 22°58'48"S, 118°57'43"E, 23 February 2010, under bark, T. Sachse (WAM T101183); 2 ♂, Area C, 89.6 km NW. of Newman, 23°00'03"S, 118°56'49"E, 18 February 2010, under bark, M. Greenham (WAM T101178); 1 ♂, 1 tritonymph, Area C, 90.6 km NW. of Newman, 22°59'52"S, 119°01'47"E, 22 February 2010, under bark, M. Greenham (WAM T101184, T101195); 2 ♂, 2 ♀, Area C, 93.7 km NW. of Newman, 22°59'55"S, 118°54'24"E, 18 February 2010, under bark, M. Greenham, Z. Hamilton (WAM T101180, T101198); 3 ♂, 1 deutonymph, BlueSpec, 18 km NE. of Nullagine, 21°49'51.70"S, 120°16'19.80"E, 1 August 2012, under bark of *Melaleuca argentea* and *Corymbia* sp., M.K. Curran, S.R. Bennett (WAM T127500, T133154, T133155, T133156); 1 ♂, Cane River Conservation Park, site CR30, 22°15'09.3"S, 115°30'45.0"E, 28 June 2011, under bark of *Corymbia* sp, J.M. Waldock (WAM T115048); 1 ♂, 2 ♀, Hillside Station, c. 150 km SE. of Wodgina Mine, 21°54'50.10"S, 119°13'55.90"E, 23 May–13 June 2014, B. Parsons (WAM T134245); 2 ♀, Hope Downs, 74 km NW. of Newman, 22°59'26"S, 119°05'28"E, 25 June 2010, under bark, G. Humphreys, P. Runham (WAM T107400, T133433); 2 ♂, Hope Downs 4, c. 100 km NW. of Newman, HD4-3, 23°09'10.7"S, 119°31'44.5"E, 12 May 2008, J. Francesconi (WAM T91720); 7 ♂, 4 ♀, Hope Downs 4, c. 100 km NW. of Newman, HD4-6, 23°09'15.7"S, 119°34'54.1"E, 10 May 2008, J. Francesconi (WAM T91718, T91721); 1 ♂, 1 ♀, same data (AM KS.131088); 1 ♂, 1 ♀, same data (QM S116491); 1 ♀, Little Sandy Desert, 11.9 km SE. of Burranbar Pool, site LSD-S5-F1, 23°52'48"S, 120°30'11"E, August 1997, S. van Leeuwen, B. Bromilow (WAM T110086); 3 ♂, 3 ♀, 1 tritonymph, Marandoo Mine Expansion, 35 km ENE. of Tom Price, 22°06'20"S, 118°18'22"E, 13 April 2007, L. Beesley, P. Runham (WAM T82334, T82335, T155130, T155131); 1 ♀, Marandoo Mine Expansion, 35 km ENE. of Tom Price, 22°07'37"S, 118°19'59"E, 12 April 2007, L. Beesley (WAM T82336); 1 ♂, Marandoo Mine Expansion, 35 km ENE. of Tom Price, 22°39'43"S, 118°10'49"E, 12 April 2007, L. Beesley (WAM T82340); 1 ♂, 1 ♀, 3 tritonymphs, Mesa G and Warramboo, 50.8 km W. of Pannawonica, 21°40'25"S, 115°50'03"E, 27 August 2009, under bark, M.A. Cowan (WAM T102897); 2 ♂, 8 ♀, 1 tritonymph, Mesa K, 10 km SW. of Pannawonica, 21°43'45"S, 116°15'18"E, 13 November 2006, D. Kamien (WAM T82356, T82355, T133117–T133125); 1 ♂, 2 ♀, 19 km SW. of Mt Brockman, site BRO936, 22°35'37"S, 117°10'23"E, 21–28 October 2004, R. Teale (WAM T73311); 4 ♂, 6 ♀, 3 tritonymphs, 1 protonymph, c. 22 km SW. of Mt Brockman, site BRO36, 22°35'37"S, 117°10'23"E, 27 October 2004, under bark of *Corymbia hamersleyana*, R. Teale, Z. Hamilton (WAM T65209); 2 ♀, 1 protonymph, Mt Webber, c. 200 km SE. of Port Hedland, 21°41'37.90"S, 119°40'43.10"E, 7–24 March 2014, dry pitfall, A. Slabber, M. Quinn (WAM T132825); 1 ♂, Mudlark, 111 km W. of Newman, 23°04'51"S, 118°41'03"E, 2 July 2011, under *Eucalyptus* bark, M. Greenham, N. Watson (WAM T117776); 10 ♂, 8 ♀, 1 tritonymph, 5 deutonymphs, Nammuldi-Silvergrass, 52.1 km NW. of Tom Price, 22°23'01"S, 117°24'23"E, 8–12 October 2008, under bark, E. Harris, M. Greenham (WAM T99572, T99573, T133182–T133191); 11 ♂, 7 ♀, Nammuldi-Silvergrass, 52.3 km NW. of Tom Price, 22°23'53"S, 117°23'30"E, 8–12 October 2008, under bark, E. Harris, M. Greenham (WAM T99575, T133192–T133195, T133408– T133410); 5 ♂, 1 tritonymph, 1 protonymph, Nammuldi-Silvergrass, 53.6 km NW. of Tom Price, 22°23'30"S, 117°22'48"E, 8–12 October 2008, under bark, E. Harris, M. Greenham (WAM T99574, T133157, T133411, T133412); 10 ♂, 10 ♀, 5 tritonymphs, Nammuldi-

Silvergrass, 79.7 km NW. of Tom Price, 22°14'28"S, 117°10'56"E, 11 May 2009, under bark, M. Greenham, R. Hamilton (WAM T102844); 1 ♀, 2 tritonymphs, 64 km NW. of Newman, 22°54'16"S, 119°20'27"E, 12 March 2011, under *Corymbia hamersleyana* bark, Z. Hamilton (WAM T110435, T133137); 13 ♂, 2 tritonymphs, 2 deutonymphs, 114.4 km NW. of Newman, 22°34'51"S, 119°00'06"E, 20 November 2011, under bark, M. Greenham, Z. Hamilton (WAM T126241, T133145–T133147); 1 ♀, Orebody 24, c. 7 km N. of Newman, 23°17'16.32"S, 119°44'48.41"E, 5–13 August 2013, leaf sifting, S. Callan (WAM T131262); 13 ♂, 4 ♀, 3 tritonymphs, 17.1 km S. of Pannawonica, Bungaroo Lease, 21°47'04"S, 116°15'31"E, 8 August 2009, under bark, M. Greenham (WAM T102835); 12 ♂, 2 ♀, 5 tritonymphs, 1 protonymph, 50.7 km W. of Pannawonica, Mesa G - Warramboo Lease, 21°37'01"S, 115°49'59"E, 27 August 2009, under bark, M. Greenham, M.A. Cowan (WAM T102892, T102893, T133414–T133421, T133426–T133431); 8 ♂, 1 ♀, 2 tritonymphs, 2 deutonymphs, 52.4 km W. of Pannawonica, Mesa G - Warramboo Lease, 21°38'09"S, 115°49'08"E, 27 August 2009, under bark, M.A. Cowan (WAM T102890, T133158, T133422–T133425); 1 tritonymph, 1 deutonymph, c. 150 km SE. of Port Hedland, Shaw River, 21°04'26.99"S, 119°14'53.22"E, 23–29 July 2011, leaf litter, N. Dight, M. Majer (WAM T117733, T117746); 1 ♂, 1 tritonymph, Robe Valley, 15 km SW. of Pannawonica, 21°43'59"S, 116°13'10"E, 26 October 2010, under bark, D. Kamien J. Cairnes (WAM T109110, T109111); 3 ♂, 1 tritonymph, Robe Valley, 16 km SW. of Pannawonica, 21°44'46"S, 116°13'12"E, 26 October 2010, under bark, J. Cairnes (WAM T109113); 1 ♂, 2 ♀, 1 tritonymph, Robe Valley, 39.6 km WSW. of Pannawonica, 21°43'51"S, 115°57'13"E, 25 October 2010, under bark, D. Kamien (WAM T109109); 1 ♂, 6 ♀, 5 km S. of Shay Gap, 20°32'S, 120°10'E, 5 October 1992, under bark of bloodwood, G. Harold (WAM T127289); 1 ♀, South Flank, c. 95 km NW. of Newman, 22°58'15.0"S, 118°47'33.7"E, 16–23 March 2016, under bark, B. Durrant (WAM T140230); 1 ♀, Southern Flank to Jinidi, 68.1 km NW. of Newman, 22°57'48"S, 119°12'58"E, 15 April 2011, under bark, R. Teale, M. Greenham (WAM T111892); 13 ♂, 1 ♀, 5 tritonymphs, 2 deutonymphs, Sulphur Springs, 21°08'27"S, 119°11'20"E, 4 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63976, T63968, T133100–T133105); 4 ♂, 3 ♀, 1 deutonymph, Sulphur Springs, 21°08'10"S, 119°12'06"E, 4 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63974); 6 ♂, 2 ♀, 2 tritonymphs, Sulphur Springs, 21°09'06"S, 119°12'10"E, 4 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63965, T63978); 8 ♂, 5 ♀, Sulphur Springs mine, 21°08'52"S, 119°12'14"E, 2 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63988, T133112–133116); 1 ♂, 2 ♀, 2 tritonymphs, 1 deutonymph, Sulphur Springs, 21°08'16"S, 119°12'20"E, 4 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63975); 2 ♂, Sulphur Springs, 20°59'03"S, 119°18'14"E, 3 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63967); 3 ♂, 2 ♀, near Sulphur Springs, 20°46'01"S, 119°19'17"E, 28 October 2007, under bark of *Corymbia hamersleyana*, M.S. Harvey, R.J. Teale (WAM T95086, T133129, T133130); 7 ♂, 4 ♀, Sulphur Springs, 20°46'10"S, 119°19'17"E, 3 September 2006, under bark of *Corymbia hamersleyana*, R. Teale, P. Runham, M. Greenham (WAM T63979, T133106–T133111); 4 ♀, Tom Price Powerline, 1 km WSW. of Tom Price, 22°42'06"S, 117°46'28"E, 8 August 2009, under bark, M. Menz (WAM T98406, T133126); 1 ♂, 3 ♀, Tom Price Powerline, 10 km NW. of Tom Price, 22°38'50"S, 117°42'32"E, 8 August 2009, under bark, M. Menz (WAM T98408, T153910); 1 ♂, 1 ♀, 1 deutonymph, 1 protonymph, Tom Price Powerline, 6 km NW. of Tom Price, 22°40'25"S, 117°44'11"E, 7 September 2008, under bark, M. Menz (WAM T98404, T98407, T133127, T133128); 3 ♂, 9 ♀, 3 tritonymphs, Tom Price Powerlines, 4.1 km WNW. of Tom Price, 22°41'10"S, 117°44'55"E, 1–30 September 2007, under bark, D. Kamien (WAM T102920, T133159–T133163); 3 ♂, 1 tritonymph, Tom Price Powerlines, 6.1 km NW. of Tom Price, 22°39'47"S, 117°43'11"E, 1–31 September 2007, under bark, E. Harris (WAM T102916, T102917, T155164); 3 ♂, 1 ♀, Tom Price Powerlines, 6.4 km NW. of Tom Price, 22°39'45"S, 117°43'48"E, 1–31 September 2007, under bark, D. Kamien (WAM T102918, T102919); 1 tritonymph, West Turner Corridor, 23 km W. of Tom Price, 22°42'22"S, 117°34'18"E, 1–31 September 2007, under bark, M. Greenham (WAM T102925); 4 ♂, 9 ♀, 4 tritonymphs, West Turner Corridor, 23 km W. of Tom Price, 22°43'04"S, 117°34'30"E, 1–30 September 2007, under bark, M. Greenham (WAM T102921, T133164–T133169); 5 ♂, 1 ♀, West Turner Corridor, 23 km W. of Tom Price, 22°43'17"S, 117°40'33"E, 1–31 September 2007, under bark, M. Greenham (WAM T10292, T102926); 4 ♂, 2 ♀, 1 tritonymph, West Turner Syncline, 35 km SW. of Tom Price, 22°40'13"S, 117°27'17"E, 18 July 2007, under bark, D. Kamien, M. Greenham (WAM T98420, T98421); 1 protonymph, West Turner Syncline, 24 km W. of Tom Price, 22°40'19"S, 117°28'01"E, 24 July 2008, under *Eucalyptus* bark, D. Kamien (WAM T98417); 3 ♂, 1 ♀, 1 deutonymph, West Turner Syncline, 33 km W. of Tom Price, 22°40'19"S, 117°28'01"E, 24 July 2008, under *Eucalyptus* bark, D. Kamien (WAM T98415); 2 ♂, 5 tritonymphs, West Turner Syncline, 31 km WSW. of Tom Price, 22°44'12"S, 117°30'09"E, 20 July 2007, under bark, D. Kamien, M. Greenham (WAM T98411, T133179, T133180); 9 ♂, 7 ♀, 2 tritonymphs, West Turner Syncline, 28 km W. of Tom Price, 22°39'57"S, 117°31'22"E, 21 July 2007, under bark, D. Kamien, M. Greenham (WAM T98410, T98422, T133138–T133144); 12 ♂, 12 ♀, 1 tritonymph, 1 deutonymph, West Turner Syncline, 22 km W. of Tom Price, 22°43'00"S, 117°34'32"E, 25 July 2008, under *Corymbia* bark, E. Harris (WAM T98413); 8 ♂, 12 ♀, West Turner Syncline, 18 km W. of Tom Price,

22°40'37"S, 117°35'53"E, 22 July 2007, under bark, D. Kamien, M. Greenham (WAM T98412, 133173–T133177); 9 ♂, 10 ♀, 2 tritonymphs, West Turner Syncline, 18 km W. of Tom Price, 22°40'12"S, 117°36'48"E, 22 July 2007, under bark, D. Kamien, M. Greenham (WAM T98409); 3 ♂, 3 ♀, West Turner Syncline, 18 km W. of Tom Price, 22°40'12"S, 117°36'48"E, 22 July 2007, under bark, D. Kamien, M. Greenham (WAM T133131–T133136); 6 ♂, 1 ♀, 3 tritonymphs, Wheatstone Biological Survey, 23 km SSE. of Onslow, 21°51'12.11"S, 115°08'51.30"E, 22 April 2009, *Corymbia* sp., G. Humphreys, M. Greenham (WAM T98750); 5 ♂, Wheatstone Biological Survey, 62 km SE. of Onslow, 22°04'55.73"S, 115°28'58.83"E, 20 April 2009, G. Humphreys, M. Greenham (WAM T98747).

DIAGNOSIS

Synsphyronus xynus differs from all other species of the genus by the combined presence of fused metatarsi and tarsi (Figure 82), a constricted anterior eye (Figure 83), eight trichobothria on the fixed chelal finger, and one trichobothrium on the movable finger (Figure 76).

DESCRIPTION

Adults

Colour (Figures 70–75) of sclerotised portions generally dark red-brown; tergites IV–X with paired darker patches. Waxy epicuticle. Setae generally aligned perpendicularly from body, each seta quadricarinate. Most cuticular surfaces roughened, but not granulate.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; setae *sbs* and *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea of ♂ and ♀ unbranched; rallum of 3 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 16 (♂, ♀) blades; lamina exterior present.

Pedipalp (Figure 81): trochanter 1.37 (♂), 1.64 (♀), femur 3.27–4.38 (♂), 3.74–4.32 (♀), patella 2.22–2.71 (♂), 2.47–2.74 (♀), chela (with pedicel) 3.28–3.85 (♂), 3.33–3.79 (♀), chela (without pedicel) 2.96–3.65 (♂), 3.13–3.56 (♀), hand (without pedicel) 1.53–1.85 (♂), 1.61–1.94 (♀) × longer than broad, movable finger 0.88–1.02 (♂), 0.86–0.97 (♀) × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 1 trichobothrium (Figure 76): *eb*, *esb* and *isb* situated basally in straight row, *est* submedially, *et* subdistally, *ib* and *ist* basally in diagonal row, and *it* subdistally, well posterior to *et*; *t* subdistally; patch of microsetae present on retrolateral margin of fixed chelal finger near *et*. Venom apparatus present in both chelal fingers, venom ducts long, terminating in nodus ramosus midway near *et* in fixed finger and midway between *t* and tip of finger in movable finger. Chelal teeth retrorse and acute distally, becoming rounded basally (Figure 77); fixed finger with 37 (♂), 35 (♀) teeth; movable finger with 27 (♂), 26 (♀) teeth; accessory teeth absent.

Carapace (Figures 72, 75): 0.82–0.90 (♂), 0.79–0.92 (♀) × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of corneate eyes (Figure 83) situated c. one-third carapace length from anterior margin; anterior eye strongly constricted; with 4 setae near anterior margin and 8 (♂) 9 (♀) near posterior margin; with numerous lyrifissures; without furrows.

Coxal region: manducatory process rounded, with 3 apical acuminate setae, plus 4 (♂, ♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 3: 4: 5: 6; ♀, 4: 5: 6: 12.

Legs (Figure 82): junction between femora and patellae I and II slightly oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.00 (♂), 3.29 (♀) × longer than deep; metatarsi and tarsi fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium much longer than claws, not divided.

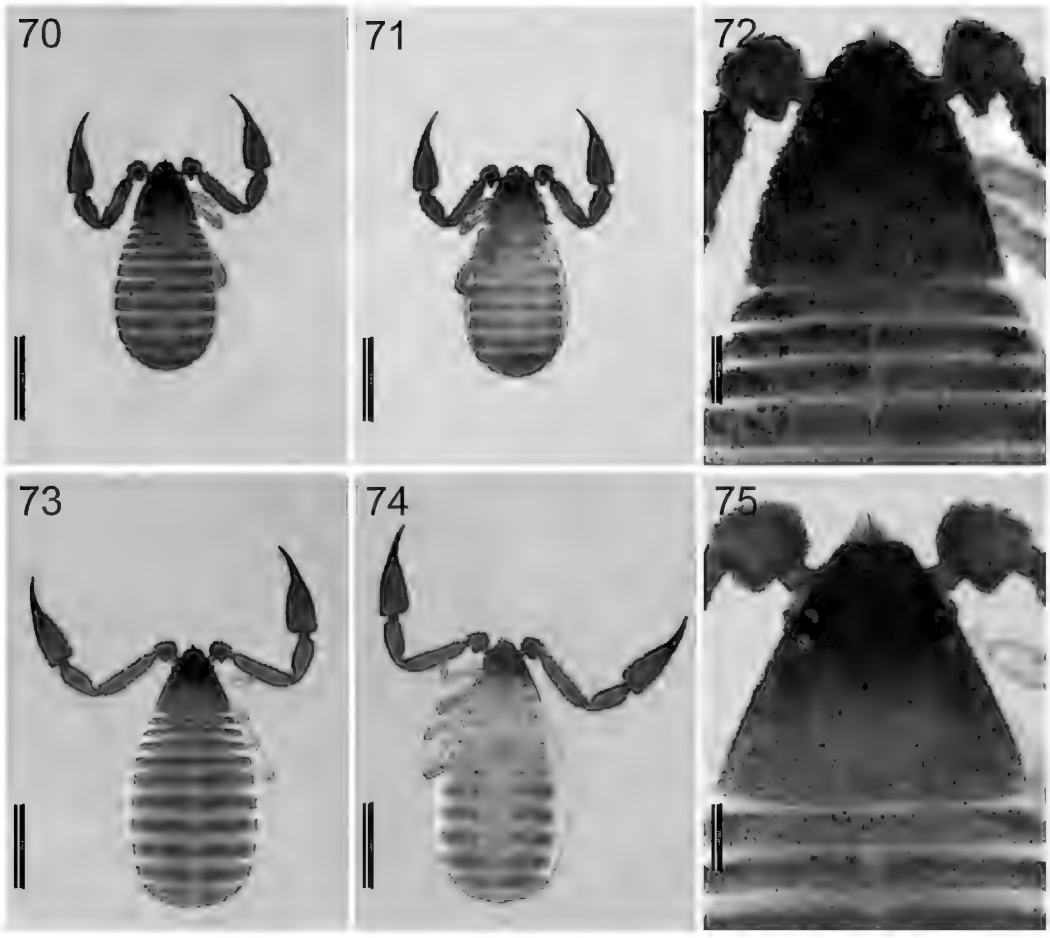
Abdomen: tergites II–X (♂, ♀) and sternites X (♂), IX–X (♀) with median suture line (Figures 70, 71, 73, 74). Tergal chaetotaxy: ♂, 4: 8: 10: 10: 11: 11: 12: 10: 10: 8: 4: 2; ♀, 10: 9: 10: 13: 14: 14: 13: 11: 7: 8: 4: 2; uniseriate; all setae quadricarinate. Sternal chaetotaxy: ♂, 6: (0) 4 [2 + 3] (0): (0) 4 (0): 4: 6: 7: 9: 8: 9: 8: 2; ♀, 8: (0) 6 (0): (0) 6 (0): 6: 8: 9: 11: 11: 10: 4: 2; uniseriate; all setae quadricarinate except for setae on sternites II–IV and medial setae on sternites V–VI, which are acuminate. Spiracles without helix. Anal plates (tergite XII and sternite XII) situated within sternite XI, surrounded by slightly raised rim. Pleural membrane wrinkled-plicate; without any setae.

Genitalia ♂: lateral apodeme laterally extended and distally broadened; anterior apodeme acute; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Genitalia ♀: with one pair of lateral cribriform plates and 2 pairs of median cribriform plates.

Dimensions ♂: holotype (WAM T135584) followed by 10 other males (when measured): Body length 2.50 (2.14–2.69). Pedipalps: trochanter 0.335/0.245, femur 0.735/0.180 (0.690–0.770/0.160–0.230), patella 0.540/0.205 (0.490–0.570/0.185–0.245), chela (with pedicel) 1.045/0.300 (1.030–1.245/0.270–0.370), chela (without pedicel) 0.990 (0.980–1.095), hand (without pedicel) length 0.520 (0.490–0.565), movable finger length 0.460 (0.475–0.525). Carapace 0.690/0.765 (0.670–0.765/0.780–0.885); eye diameter, anterior 0.035, posterior 0.055. Leg IV: femur + patella 0.540/0.180, tibia 0.340/0.135, tarsus 0.265/0.075.

Dimensions ♀: paratype (WAM T135549) followed by 10 other females (when measured): Body length 3.12 (2.36–3.23). Pedipalps: trochanter 0.385/0.235, femur 0.830/0.205 (0.750–0.815/0.185–0.215), patella 0.610/0.225 (0.545–0.625/0.210–0.235), chela (with pedicel) 1.195/0.315 (1.150–1.200/0.320–0.360), chela



FIGURES 70–75 *Synsphyronus xynus* sp. nov., holotype ♂ (WAM T135584): 70) body, dorsal; 71) body, ventral; 72) cephalothorax, dorsal. Paratype ♀ (WAM T135549): 73) body, dorsal; 74) body, ventral; 75) cephalothorax, dorsal.

(without pedicel) 1.120 (1.090–1.125), hand (without pedicel) length 0.610 (0.545–0.610), movable finger length 0.505 (0.510–0.555). Carapace 0.770/0.975 (0.710–0.760/0.800–0.940); eye diameter, anterior 0.030, posterior 0.055. Leg IV: femur + patella 0.625/0.190, tibia 0.390/0.110, tarsus 0.300/0.085.

Tritonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

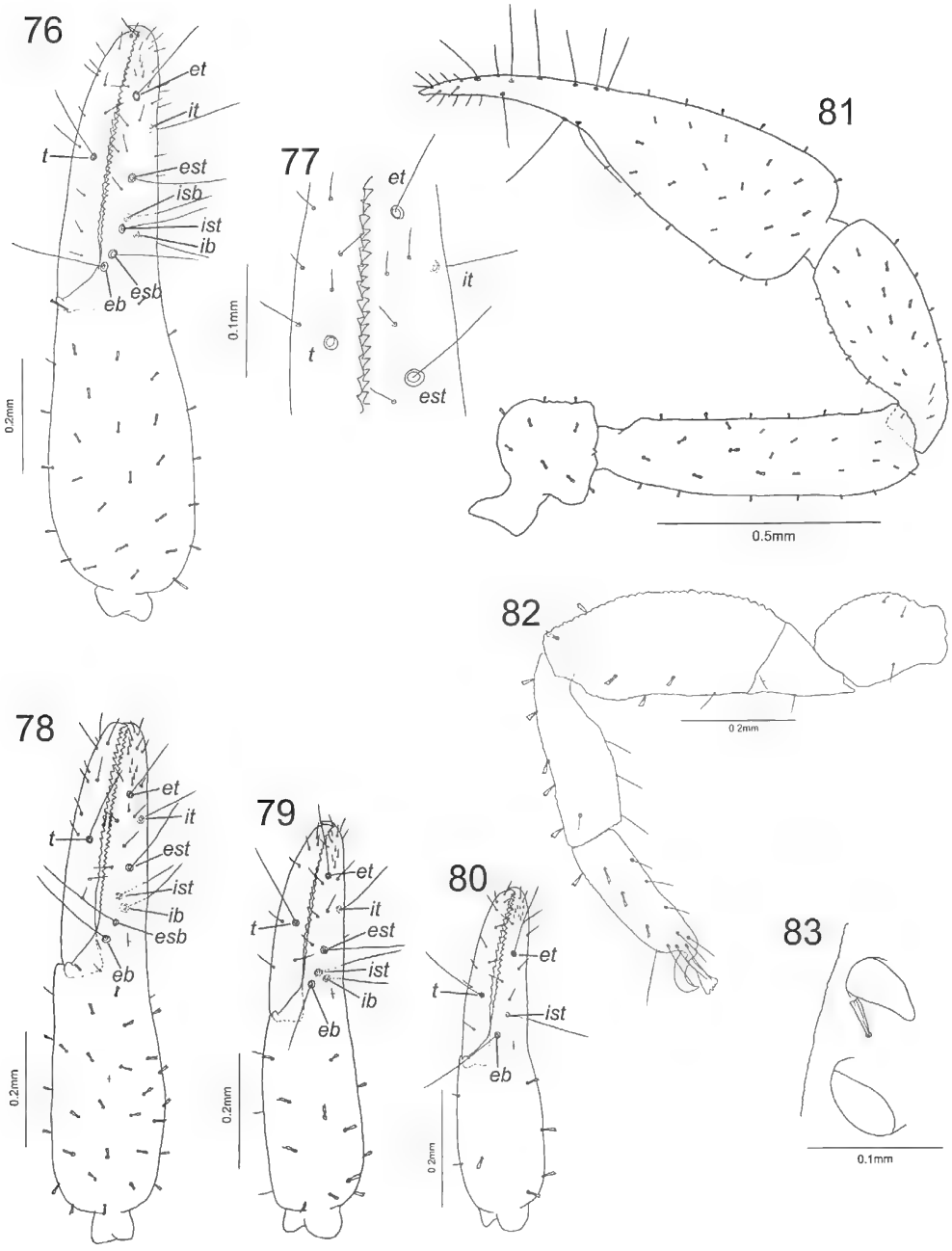
Pedipalp: trochanter 1.53, femur 3.84, patella 2.49, chela (with pedicel) 3.73, chela (without pedicel) 3.54, hand (without pedicel) 1.81 × longer than broad, and movable finger 0.93 × longer than hand (without pedicel). Fixed chelal finger with 7 trichobothria, movable chelal finger with 1 trichobothrium (Figure 78): *eb*, *esb*, *ist* and *ib* situated basally; *est* situated medially; *et* subdistally; *it* submedially; *t* submedially.

Carapace: 0.83 × longer than broad; with 6 setae near posterior margin.

Legs: much as in adults.

Abdomen: tergal chaetotaxy: 8: 8: 8: 10: 10: 10: 11: 8: 9: 4: 4: 4. Sternal chaetotaxy: 0: (0) 4 (0): (0) 4 (0): 4: 4: 4: 6: 10: 8: 2: 2.

Dimensions: WAM T155164: Body length 1.73. Pedipalps: trochanter 0.290/0.190, femur 0.595/0.155, patella 0.435/0.175, chela (with pedicel) 0.895/0.0.240, chela (without pedicel) 0.850, hand (without pedicel) length 0.435, movable finger length 0.405. Carapace 0.575/0.690.



FIGURES 76–83 *Synsphyronus xynus* sp. nov., holotype ♂ (WAM T135584), unless stated otherwise: 76) left chela, retrolateral; 77) detail of chelal teeth, retrolateral; 78) left chela, retrolateral, tritonymph (WAM T155164); 79) left chela, retrolateral, deutonymph (WAM T133157); 80) left chela, retrolateral, protonymph (WAM T98417); 81) right pedipalp, dorsal; 82) left leg IV, retrolateral; 83) left eyes, dorsal.

Deutonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 5 setae on hand and 1 on movable finger; galea unbranched.

Pedipalp: trochanter 1.44, femur 3.44, patella 2.13, chela (with pedicel) 3.64, chela (without pedicel) 3.44, hand (without pedicel) 1.72 × longer than broad, and movable finger 1.00 × longer than hand (without pedicel). Fixed chelal finger with 6 trichobothria, movable chelal finger with 1 trichobothrium (Figure 79): *eb*, *ist* and *ib* situated basally; *est* situated medially; *et* distally; *it* subdistally; *t* submedially.

Carapace: 0.86 × longer than broad; with 28 setae including 2 near anterior margin and 4 near posterior margin.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 3: 6: 6: 6: 6: 6: 6: 6: 7: 6: 2: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 2: 2: 2: 3: 6: 6: 4: 2.

Dimensions: WAM T133157: Body length 1.51. Pedipalps: trochanter 0.230/0.160, femur 0.465/0.135, patella 0.330/0.155, chela (with pedicel) 0.710/0.195, chela (without pedicel) 0.670, hand (without pedicel) length 0.335, movable finger length 0.335. Carapace 0.510/0.590.

Protonymph

Colour mostly as for adults, but generally paler.

Chelicera: with 4 setae on hand and 0 on movable finger; galea unbranched.

Pedipalp: trochanter 1.50, femur 3.22, patella 2.08, chela (with pedicel) 3.66, chela (without pedicel) 3.41, hand (without pedicel) 1.75 × longer than broad, and movable finger 0.98 × longer than hand (without pedicel). Fixed chelal finger with 3 trichobothria, movable chelal finger with 1 trichobothrium (Figure 80): *eb* and *ist* situated basally; *et* situated subdistally; *t* situated submedially.

Carapace: 0.86 × longer than broad.

Legs: metatarsi and tarsi fused.

Abdomen: tergal chaetotaxy: 2: 4: 4: 4: 4: 4: 4: 4: 4: 4: 2: 2. Sternal chaetotaxy: 0: (0) 2 (0): (0) 2 (0): 2: 2: 2: 2: 2: 2: 4: 2.

Dimensions: WAM T98417: Body length 1.38. Pedipalps: trochanter 0.180/0.120, femur 0.370/0.115, patella 0.270/0.130, chela (with pedicel) 0.585/0.160, chela (without pedicel) 0.545, hand (without pedicel) length 0.280, movable finger length 0.275. Carapace 0.425/0.495.

MOLECULAR DATA

We successfully sequenced 98 specimens of this species for COI, which have been accessioned in GenBank (Table 1). Sequence data from a single specimen of this species were reported by Harvey et al. (2020) under the name *Synsphyronus* 'PSE093'.

REMARKS

Synsphyronus xynus has features that suggest a close relationship with the *S. paradoxus* group of species, including fused metatarsi and tarsi (Figure 82), a broad chelal hand (Figure 81) and a strongly constricted anterior eye (Figure 83). This group currently includes species with differing numbers of trichobothria: *S. paradoxus* from south-eastern Australia with 8/2, *S. hadronennus* from the Northern Territory and *S. meganennus* from New South Wales with 8/3, and *S. heptatrichus* from the Northern Territory with 7/2. The new species differs from them by having an 8/1 arrangement (Figure 76).

Synsphyronus xynus occurs throughout the Pilbara region of Western Australia where it occurs under tree bark, including tree species such as *Corymbia hamersleyana*, *Melaleuca argentea* and unidentified species of *Eucalyptus*. This corticolous habitat is similar to other species of the *paradoxus* group, which are all found under tree bark (Harvey 1987b).

ETYMOLOGY

This species is named for its widespread distribution in the Pilbara region of Western Australia (*xynus*, common) (Brown 1956).

Synsphyronus gurdoni Harvey, Abrams & Burger, 2015

Synsphyronus gurdoni Harvey, Abrams and Burger 2015: 138–142, figures 1–13.

REMARKS

The description of *S. gurdoni* by Harvey et al. (2015a) contained incorrect ratios for some pedipalpal segments. The corrected ratios are presented here:

Femur 2.44–3.42 (♂), 2.90–3.60 (♀), patella 2.12–2.62 (♂), 2.32–2.76 (♀), chela (with pedicel) 3.12–3.80 (♂), 3.25–3.53 (♀), chela (without pedicel) 3.15–3.42 (♂), 2.97–3.30 (♀) × longer than broad.

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A new species of the pseudoscorpion genus *Anatemnus* (Pseudoscorpiones: Atemnidae) from tropical Australia

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ABSTRACT – The third Australian species of the pseudoscorpion genus *Anatemnus* is described from tropical Australia: *Anatemnus wongalara* sp. nov.

KEYWORDS: taxonomy, morphology, Arachnida

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INTRODUCTION

The pseudoscorpion family Atemnidae is currently represented by two subfamilies and 21 genera: Atemninae includes 15 genera and Miratemninae is represented by six genera. They occur in most regions of the world, but are more diverse in tropical ecosystems. The genus *Anatemnus* Beier, 1932 is currently represented by 22 species, with most occurring in Australasia (see Alexander et al. 2014; Gao and Zhang 2016; Harvey 2013; Hu and Zhang 2012). The only species known from outside Asia are *A. elongatus* (Ellingsen, 1902) from northern South America, *A. seychellesensis* Beier, 1940 from Seychelles Islands, and *A. madecassus* Beier, 1932, *A. oswaldi* (Tullgren, 1907), *A. subindicus* (Ellingsen, 1910) and *A. voeltzkowi* (Ellingsen, 1908) from Madagascar. Like many atemnid genera, *Anatemnus* is poorly defined and most likely polyphyletic (Klausen 2005).

The Australian fauna currently comprises *A. cavernicola* (Beier, 1976) from a cave in north-western New South Wales (Alexander et al. 2014; Beier 1976) and *A. subvastus* Alexander, Burger and Harvey, 2014 from subterranean cavities in the Pilbara region of Western Australia (Alexander et al. 2014). This paper reports the discovery of a previously undescribed species of *Anatemnus* collected from northern Australia during a BushBlitz expedition to Wongalara Wildlife Sanctuary, situated in the tropical Northern Territory.

MATERIAL AND METHODS

The material utilised in the present study is lodged in the Museum and Art Gallery of the Northern Territory, Darwin (NTM). They were examined by preparing temporary slide mounts by immersing the specimen in 75% lactic acid at room temperature for one to several days, and mounting them on microscope slides with 10 or 12 mm coverslips supported by small sections of nylon fishing line. Specimens were examined with a Leica MZ16 dissecting microscope and a Olympus BH–2 compound microscopes, and illustrated with the aid of a drawing tube. Measurements (in mm) were taken at the highest possible magnification using an ocular graticule. After study the specimens were rinsed in water and returned to 75% ethanol with the dissected portions placed in 12 × 3 mm glass genitalia microvials (BioQuip Products, Inc.).

Terminology and mensuration largely follow Chamberlin (1931), with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992), chelicera (Harvey & Edward 2007; Judson 2007) and faces of the appendages (Harvey et al. 2012). Measurements were taken to the nearest 0.005 mm, and in the Dimensions sections expressed as length/width, except for the leg measurements which are length/depth.

Family Atemnidae Kishida, 1929

Subfamily Atemninae Kishida, 1929

Genus *Anatemnus* Beier, 1932

urn:lsid:zoobank.org:act:6A7C3B4A-E5BB-4051-B9AD-C27C0BA22620

Anatemnus Beier 1932: 578.

TYPE SPECIES

Chelifer javanus Thorell, 1883, by original designation.

REMARKS

The new species described here is undoubtedly most similar to the Australian species *A. cavernicola* (Beier, 1976) and *A. subvastus* Alexander, Burger and Harvey, 2014 due to the arrangement of the trichobothria in which *isb* and *it* are widely spaced (Alexander et al. 2014; Beier 1976). Although this arrangement also occurs in the type species *A. javanus*, the assignment of the Australian species to *Anatemnus* was regarded as provisional by Alexander et al. (2014) as the generic classification and relationships of the Atemnidae are poorly understood and in need of critical reevaluation (Klausen 2005).

Anatemnus wongalara sp. nov.

Figures 1–11

urn:lsid:zoobank.org:act:57B44BF5-AABC-4D04-8BAE-E3B99D625D68

MATERIAL EXAMINED

Holotype

Australia: ***Northern Territory*****:** ♂, Wongalara Wildlife Sanctuary, Bokalla Creek, 14°07'50"S, 134°20'38"E, 96 m, 29 May 2012, forest leaf litter, M.S. Harvey, M. Cheng (NTM A005312).

Paratype

Australia: ***Northern Territory*****:** 1 ♀, collected with holotype (NTM A005318).

DIAGNOSIS

Anatemnus wongalara shares with the following species of *Anatemnus* the widely spaced *isb* and *it*: *A. angustus* Redikorzev, 1938, *A. cavernicola* (Beier, 1976), *A. chaozhouensis* Hu and Zhang, 2012, *A. elongatus* (Ellingsen, 1902), *A. javanus* (Thorell, 1883), *A. pugilatorius* Beier, 1965 and *A. subvastus* Alexander, Burger and Harvey, 2014 (see Alexander et al. 2014; Beier 1932b, 1951, 1965, 1976; Hu and Zhang 2012; With 1908). It differs from them as follows: from *A. angustus*, *A. elongatus*, *A. javanus* and *A. pugilatorius* by the thinner pedipalpal segments; from *A. cavernicola* by the broader pedipalpal femur and patella [femur 2.78 (♂), 2.88 (♀) and patella 2.32 (♂), 2.33 (♀) × longer than broad in *A. wongalara* versus femur 3.3 (♀), patella 3.0 (♀) and chela (with pedicel) (♀) 2.9 × longer than broad in *A. cavernicola*]; and from *A. subvastus* by its larger size [e.g. pedipalpal femur 0.91 (♂), 0.94 (♀) mm in *A. wongalara* versus 0.59–0.71 (♂), 0.64 (♀) mm in *A. subvastus*].

DESCRIPTION

Adults

Colour (Figures 1–6): pedipalps red-brown; carapace paler; legs yellow-brown.

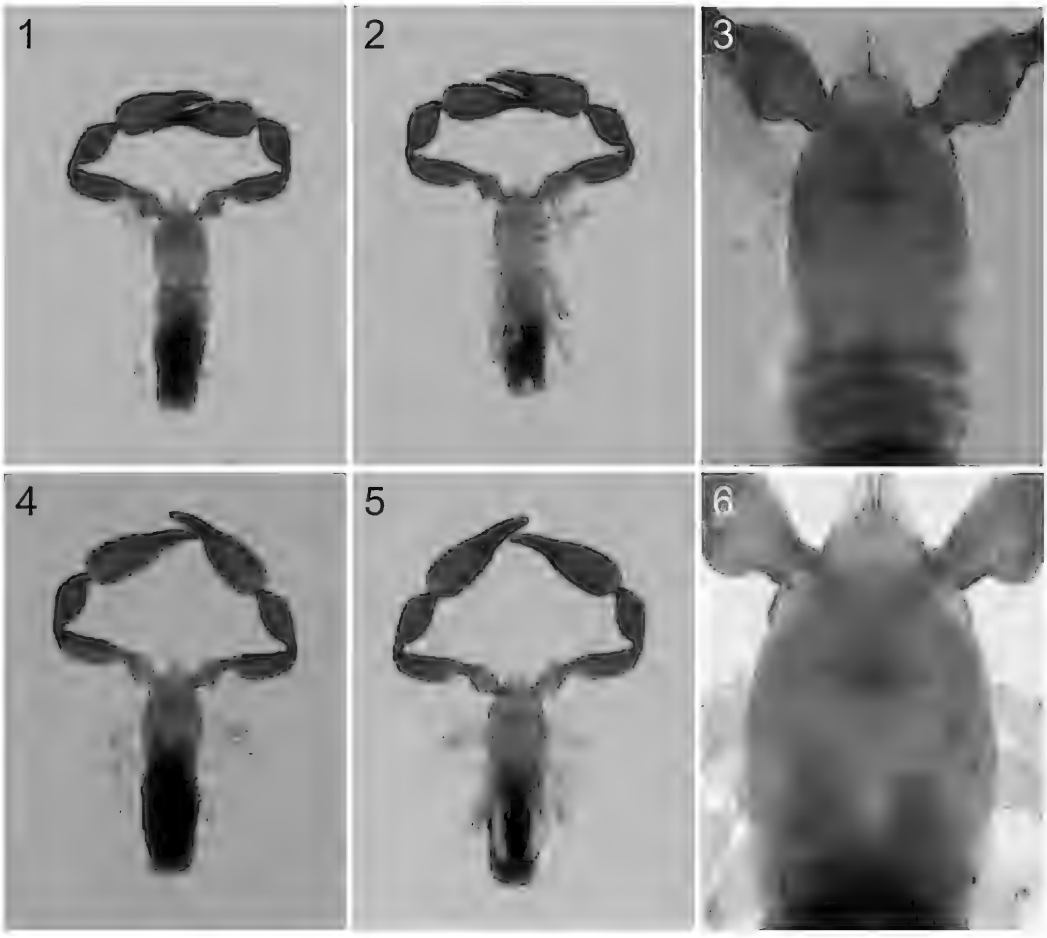
Cuticle and setae: most surfaces smooth, except for some pedipalpal segments which have granulations: dorsal face of trochanter, prolateral face of femur, patella and chela. Setae generally aligned perpendicularly from body, each seta acicular and very slightly curved.

Chelicera: with 4 setae on hand and 1 subdistal seta on movable finger, all setae acuminate, except for *bs* which is finely denticulate; seta *sbs* absent; *bs* shorter than others; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea of ♂ and ♀ long and slender with 4 well-defined rami (Figure 10); rallum of 4 blades, the most distal blade with spinules on leading edge, other blades smooth; serrula exterior with 27 (♂), 24 (♀) blades; lamina exterior present.

Pedipalp (Figure 8): trochanter 1.93 (♂), 2.02 (♀), femur 2.78 (♂), 2.88 (♀), patella 2.32 (♂), 2.33 (♀), chela (with pedicel) 2.90 (♂), 2.93 (♀), chela (without pedicel) 2.70 (♂), 2.74 (♀), hand 1.51 (♂), 1.72 (♀) × longer than broad, hand 0.88 (♂), 0.69 (♀) × longer than movable finger. Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Figure 9): *eb* and *esb* situated at base of fixed finger on retrolateral face; *est* closer to *et* than to *esb*; *ib* and *ist* situated at base of fixed finger on prolateral face; *isb* about level with *est*; *it* midway between *isb* and tip of finger; *et* distad to *it*; *sb* much closer to *b* than to *st*; *st* slightly closer to *t* than to *sb*. Venom apparatus only present in fixed chelal finger, venom ducts short, terminating in inflated nodus ramosus between *it* and *est*. Both chelal fingers straight in lateral view (Figure 9). Chelal teeth: distal teeth pointed, with basal teeth becoming progressively more rounded; fixed finger with 34 (♂), 35 (♀) teeth; movable finger with 40 (♂), 41 (♀) teeth; accessory teeth absent; with 1 (♂), 3 (♀) small sense spots near *sb*.

Carapace (Figures 3–4, 7): 1.23 (♂), 1.25 (♀) × longer than broad; eyespots absent; with 45 (♂), 51 (♀) setae including 2 near anterior margin and 6 (♂), 8 (♀) near posterior margin; without obvious furrows, but with a faint medial furrow using high magnification.

Coxal region: manducatory process pointed, with 3 apical acuminate setae, 1 sub-oral seta plus 26 (♂), 25 (♀) additional setae; medial maxillary lyrifissure situated submedially; chaetotaxy of coxae I–IV: ♂, 9: 9: 8: 12; ♀, 11: 11: 11: 14.



FIGURES 1–6 *Anatemnus wongalara* sp. nov., holotype ♂ (NTM A005312): 1) dorsal; 2) ventral; 3) cephalothorax, dorsal. Paratype ♀ (NTM A005318): 4) dorsal; 5) ventral; 6) cephalothorax, dorsal.

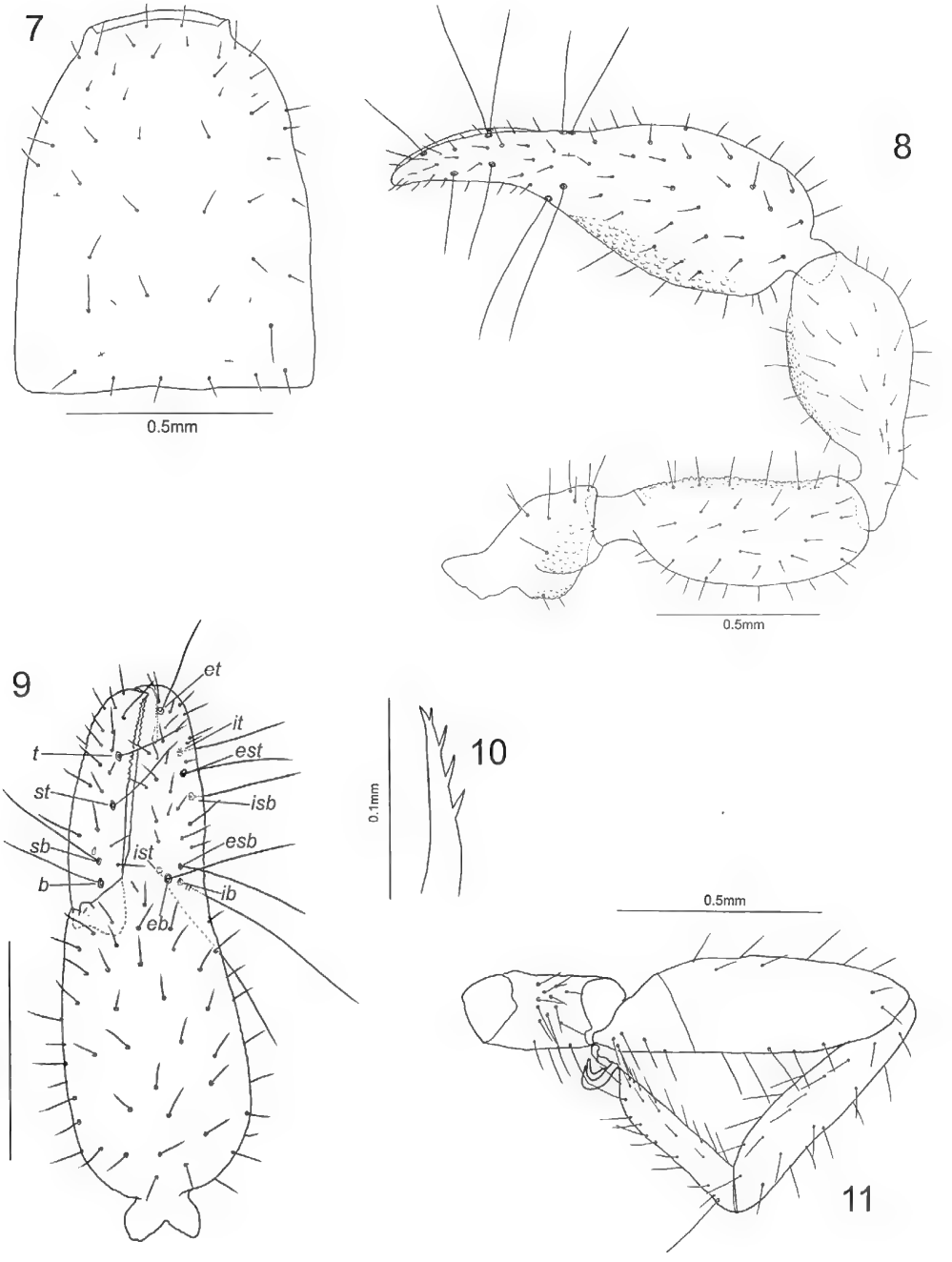
Legs (Figure 11): junction between femora and patellae I and II oblique to long axis; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.39 (♂), 3.37 (♀) × longer than deep; tarsus with basal tactile seta, TS = 0.11 (♂), 0.10 (♀); subterminal tarsal setae arcuate and acute; arolium slightly longer than claws, not divided.

Abdomen: tergites without median suture line (Figures 1–2, 4–5). Tergal chaetotaxy: ♂, 9: 9: 9: 10: 11: 11: 11: 11: 11: 13 (including 4 tactile setae): 8 (including 2 tactile setae): 2; ♀, 9: 9: 11: 13: 13: 12: 12: 11: 13: 17 (including 4 tactile setae): 8 (including 2 tactile setae): 2; uniseriate except for lateral discal setae on tergites IV–X; all setae long and acuminate. Sternal chaetotaxy: ♂, 15: (1) 7 [0 + 0] (1): (1) 11 (1): 15: 14: 15: 13: 16: 14 (including 4 tactile setae): 10 (including 4 tactile setae): 2; ♀, 12: (2) 11 (2): (1) 19 (1): 19: 19: 18: 16: 17: 18 (including 4 tactile setae): 11 (including 4 tactile setae): 2; uniseriate except for lateral discal setae on most sternites; all setae long and acuminate. Spiracles with helix. Pleural membrane longitudinally striate; without setae.

Genitalia ♂: dorsal apodeme with long and rounded apex, ejaculatory canal atrium broad, lateral apodemes spherical, lateral rods Y-shaped with rounded apices, hooked branches wide, genital atrium without genital setae.

Genitalia ♀: with single anteriorly directed spermathecal lobes and 1 pair of small lateral cribriform plates.

Dimensions ♂: holotype (NTM): Body length 2.78. Pedipalps: trochanter 0.520/0.270, femur 0.905/0.325, patella 0.895/0.385, chela (with pedicel) 1.390/0.480,



FIGURES 7–11 *Anatemnus wongalara* sp. nov., holotype ♂ (NTM A005312): 7) carapace; 8) right pedipalp, dorsal; 9) left chela, lateral; 10) left leg IV, retrolateral; 11, right galea, dorsal.

chela (without pedicel) 1.295, hand (without pedicel) length 0.725, movable finger length 0.640. Carapace 0.895/0.725. Leg IV: femur + patella 0.780/0.230, tibia 0.670/0.135, tarsus 0.460/0.090.

Dimensions ♀: paratype (NTM): Body length 2.80. Pedipalps: trochanter 0.555/0.275, femur 0.935/0.325, patella 0.885/0.380, chela (with pedicel) 1.510/0.515, chela (without pedicel) 1.410, hand (without pedicel) length 0.885, movable finger length 0.610. Carapace 1.025/0.820. Leg IV: femur + patella 0.860/0.255, tibia 0.730/0.135, tarsus 0.520/0.095.

REMARKS

The specimens of *Anatemnus wongalara* were collected from tropical vine thicket litter on a low rocky hill.

ETYMOLOGY

The species epithet is a noun in apposition based on the locality Wongalara. We are grateful to Zhizhong Gao and Jana Christophoryova for their very helpful comments on the manuscript.

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Two new species of the pseudoscorpion genus *Geogarypus* (Pseudoscorpiones: Geogarypidae) from northern Australia

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ABSTRACT – The pseudoscorpion genus *Geogarypus* is widely distributed around the world, but with only six species recorded from Australia. Two new species are described from northern Australia: *G. facetus* from Northern Territory and *G. plusculus* from Western Australia, and COI barcodes are provided for both species.

KEYWORDS: taxonomy, morphology, short-range endemics, BushBlitz, COI barcode

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INTRODUCTION

The pseudoscorpion genus *Geogarypus* Chamberlin, 1930 is widely distributed around the world, and has been recorded from all major biogeographic zones except for the Nearctic (e.g. Harvey 2013). Members of the genus are most commonly found in tropical and subtropical ecotypes in all continents, but may also extend into temperate zones such as southern South America (e.g. Beier 1955, 1959; Harvey 1987), southern Australia (Harvey 1986), southern Africa (e.g. Beier 1947; Neethling and Haddad 2016), the Mediterranean region (e.g. Beier 1961, 1963a, b; Gardini et al. 2017; Harvey 2011), Central Asia and the Tibetan Plateau (e.g. Beier 1974; Dashdamirov 1993; Redikorzev 1934) and the Middle East (e.g. Beier 1963a; Nassirkhani 2014). There are currently 49 described Holocene species of *Geogarypus*, with a further three species described from Eocene Baltic amber fossils (Beier 1937; Henderickx 2005; Henderickx and Perkovsky 2012). The Australian fauna consists of just six species, with *G. connatus* Harvey, 1986, *G. exochus* Harvey, 1986, *G. pisinnus* Harvey, 1986, *G. taylori* Harvey, 1986 and *G. rhantus* Harvey, 1981 (Harvey 1981, 1986) endemic to Australia, and the widely distributed Indo-Pacific species *G. longidigitatus* (Rainbow, 1897) recorded from northern Australia (Harvey 2000).

This paper reports the discovery of two previously undescribed species of *Geogarypus* collected from northern Australia during BushBlitz expeditions.

MATERIAL AND METHODS

The material utilised in the present study is lodged in the Museum and Art Gallery of the Northern Territory, Darwin (NTM) and the Western Australian Museum, Perth (WAM). They were examined by preparing temporary slide mounts by immersing the specimen in 75% lactic acid at room temperature for one to several days, and mounting them on microscope slides with 10 or 12 mm coverslips supported by small sections of nylon fishing line. Specimens were examined with a Leica MZ16 dissecting microscope, a Leica DM2500 or Olympus BH–2 compound microscopes, and illustrated with the aid of a drawing tube. Measurements (in mm) were taken at the highest possible magnification using an ocular graticule. After study the specimens were rinsed in water and returned to 75% ethanol with the dissected portions placed in 12 × 3 mm glass genitalia microvials (BioQuip Products, Inc.).

Terminology and mensuration largely follow Chamberlin (1931), with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992), chelicera (Harvey and Edward 2007; Judson 2007) and faces of the appendages (Harvey et al. 2012). Measurements were taken to the nearest 0.005 mm, and in the Dimensions sections expressed as length/width, except for the leg measurements which are length/depth.

Molecular sequence data were obtained from two *Geogarypus* specimens. The techniques used to obtain the Cytochrome Oxidase 1 sequence data are outlined in Harvey et al. (2015) and Harvey et al. (2020).

Family Geogarypidae Chamberlin, 1930

Genus *Geogarypus* Chamberlin, 1930

urn:lsid:zoobank.org:act: 0954EDF3-4758-4A78-9793-9A4B1A49A655

Geogarypus Chamberlin 1930: 609.

Geogarypus (Indogarypus) Beier 1957: 25.

TYPE SPECIES

Geogarypus: *Garypus minor* L. Koch, 1873, by original designation.

Geogarypus (Indogarypus): *Garypus indicus* Beier, 1930, by original designation.

REMARKS

The familial and generic classification of this group of pseudoscorpions has altered in recent decades. *Geogarypus* was initially described by Chamberlin (1930) as the sole member of the subfamily Geogarypinae within the Garypidae. Harvey (1986) raised Geogarypidae to full family level, citing significant differences between both families which were confirmed in a later cladistic analysis (Harvey 1992). Recently, using phylogenomic data, Benavides et al. (2019) found Geogarypidae to be sister to Hesperolpiidae + Garypidae within the Garypoidea.

For more than 50 years after its inception, *Geogarypus* was the only genus of the group, but two additional subgenera were recognized, *Geogarypus (Afrogarypus)* Beier, 1931 and *Geogarypus (Indogarypus)* Beier, 1957 based mostly on differences in the shape of the chelal hand. Harvey (1986) treated them as distinct genera but Novák and Harvey (2019) have recently regarded *Indogarypus* as a synonym of *Geogarypus*, due to the lack of noticeable differences between them. This leaves the family with just two genera, *Geogarypus* which is widespread around the world including many oceanic islands, and *Afrogarypus* which is restricted to the Afrotropical region.

Geogarypus facetus sp. nov.

Figures 1–8

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MATERIAL EXAMINED

Holotype

Australia: ***Northern Territory:*** ♂, Wongalara, 14°12'20"S, 134°22'14"E, 136 m, 3 June 2012, under rocks, M.S. Harvey, et al. (NTM A005319).

DIAGNOSIS

Geogarypus facetus most closely resembles *G. exochus* from Queensland and *G. plusculus* from the Northern Territory by the slight expansion of the prolateral margin of the chelal hand (Figure 6). It differs from *G. exochus* by the position of trichobothrium *st* which is midway between *t* and *sb* in *G. facetus* (Figure 12) and noticeably closer to *t* in *G. exochus*. It differs from *G. plusculus* by the colour pattern of the carapace which is mostly brown in *G. facetus* (Figure 3), but contains extensive pale areas in *G. plusculus* (Figure 11). It also differs from *G. exochus* and *G. plusculus* by the low number of setae on the posterior margin of the carapace (4 setae) and tergites I–XI (1: 4: 4: 3: 5: 5: 5: 4: 3: 3: 2), compared with 8–11 (*G. exochus*) or 11 (*G. plusculus*) setae on the carapace margin, and 7–9: 10: 7–11: 9–11: 8–11: 9–12: 9–10: 8–10: 9: 6–8: 6: 2 tergal setae in *G. exochus* and 8: 8: 8: 10: 10: 10: 10: 8: 8: 8: 6: 2 setae in *G. plusculus*.

DESCRIPTION

Adults

Male only. Colour (Figures 1–3) of sclerotised portions generally brown, including pedipalpal trochanter; carapace brown with a large pale patch on cucullus and

TABLE 1 Specimens used to generate COI barcodes of two species of *Geogarypus*.

Species	Registration No.	Type status and sex	GenBank No.
Geogarypus facetus sp. nov.	NTM A005319	holotype ♂	OK017072
Geogarypus plusculus sp. nov.	WAM T142009	paratype ♂	OK017073

FIGURES 1–3 *Geogarypus facetus* sp. nov., holotype ♂ (NTM A005319): 1) dorsal; 2) ventral; 3) cephalothorax, dorsal.

paired patches on metazone; tergites generally pale, with darker patches laterally and medially on tergites I–III and sublaterally on tergites IV–X; sternites generally pale with paired darker patches on sternites V–X. Setae small and curved.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea short and triangular, unbranched; rallum of 1 short blade; serrula exterior with 13 blades; lamina exterior present.

Pedipalp (Figure 6): trochanter 1.60, femur 4.00, patella 2.81, chela (with pedicel) 3.72, chela (without pedicel) 3.63, hand 1.65 × longer than broad, movable finger 1.34 × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with 4 trichobothria (Figure 4); *eb* and *esb* situated basally; *est* subbasally; *et* subdistally; *ib* subbasally, opposite *est*; *isb*, *ist* and *it* subdistally; *b* and *sb* situated subbasally, *st* situated closer to *sb* than *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating near *isb* in fixed finger and near *st* in movable finger. Chelal teeth diastemodentate; fixed finger with 26 teeth in main row, most strongly curved, the basal teeth becoming progressively smaller, plus 5 smaller curved teeth in prolateral accessory row; movable finger with 26 teeth, the 16 or so distalmost teeth retrorse and curved, the 10 or so basalmost teeth rounded, accessory teeth absent. Retrolateral face of fixed finger with several pit-like structures.

Carapace (Figure 3): 0.86 × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 8) situated *c.* one-third carapace length from anterior margin; anterior eye broad; with 4 setae near anterior margin and 4 near posterior margin; with several lyrifissures; without furrows.

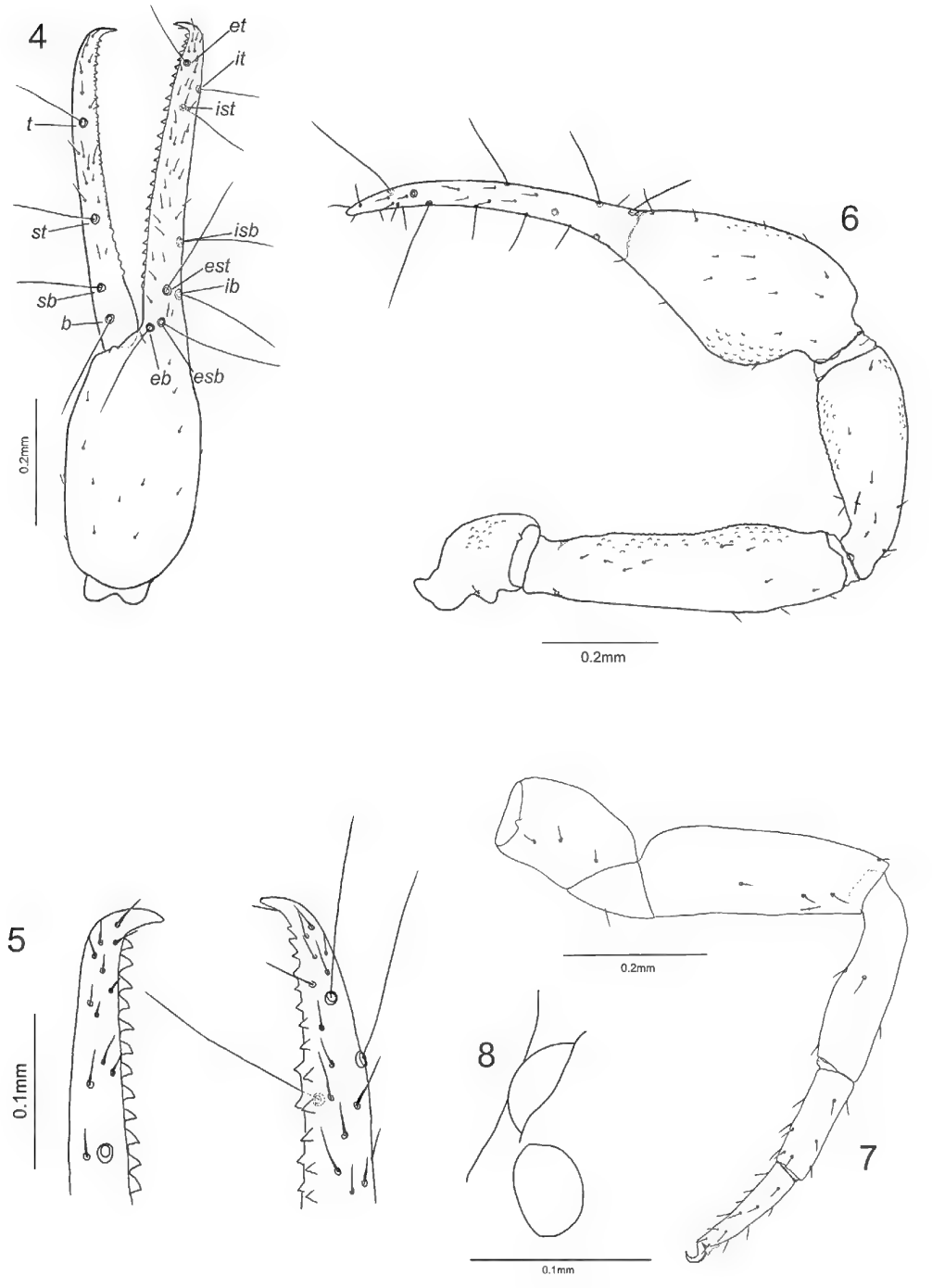
Coxal region (Figure 2): manducatory process pointed, with 3 apical acuminate setae, plus 8 additional setae; medial maxillary lyrifissure situated subdistally; chaetotaxy of coxae I–IV: 6: 8: 8: 13.

Legs (Figure 7): femora I and II longer than patellae I and II; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.93 × longer than broad; metatarsi and tarsi not fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium longer than claws, not divided.

Abdomen: tergites and sternites without median suture line (Figures 1–4). Tergal chaetotaxy: 1: 4: 4: 3: 5: 5: 5: 4: 3: 3: 2: 2; uniseriate. Sternal chaetotaxy: 6: (0) 6 [2 + 2] (0): (1) 2 (1): 8: 8: 8: 8: 8: 6: 2: 0; uniseriate. Spiracles with helix. Pleural membrane wrinkled-plicate; with several small curved setae.

Genitalia: lateral apodeme laterally extended and distally broadened; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Dimensions: holotype (WAM T124486): Body length 1.55. Pedipalps: trochanter 0.240/0.150, femur 0.540/0.135, patella 0.380/0.135, chela (with pedicel) 0.855/0.230, chela (without pedicel) 0.835, hand (without pedicel) length 0.380, movable finger length 0.510. Carapace 0.500/0.580; eye diameter, anterior 0.065, posterior 0.050. Leg IV: femur + patella 0.428/0.109, tibia 0.271/0.079, metatarsus 0.150/0.050, tarsus 0.150/0.038.



FIGURES 4–8 *Geogarypus facetus* sp. nov., holotype ♂ (NTM A005319): 4) left chela, retrolateral; 5) left chelal fingers, retrolateral; 6) right pedipalp, dorsal; 7) left leg IV, lateral; 8) left ocular region, dorsal.

MOLECULAR DATA

The holotype male of this species was successfully sequenced for COI, and accessioned in GenBank under Accession No. OK017072 (Table 1).

REMARKS

The specimen described here was collected under a rock within Wongalara, a large sanctuary situated in the southern Arnhem Land, Northern Territory.

ETYMOLOGY

The specific epithet refers to the beauty of this species (*facetus*, Latin, fine, elegant, well made) (Brown 1956).

***Geogarypus plusculus* sp. nov.**

Figures 9–16

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MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Cape Range National Park, Shothole Canyon Road, lookout, 22°03'52.01"S 114°00'38.42"E, 22 June 2019, under rocks, M.S. Harvey (WAM T148079).

Paratype

Australia: ***Western Australia:*** 1 ♂, Cape Range National Park, outside cave C–79, 22°05'31"S, 114°00'13"E, 309 m, 18 August 2016, sifting litter, J.M. Waldock, W.F. Humphreys, R.D. Brooks (WAM T142009).

DIAGNOSIS

Geogarypus plusculus most closely resembles *G. exochus* from Queensland and *G. facetus* from the Northern Territory by the slight expansion of the prolateral margin of the chelal hand (Figure 14). It differs from *G. exochus* by the position of trichobothrium *st* which is midway between *t* and *sb* in *G. plusculus* (Figure 12) and noticeably closer to *t* in *G. exochus*. It differs from *G. facetus* by the colour pattern of the carapace which contains extensive pale areas (Figure 11) but is mostly brown in *G. facetus* (Figure 3).

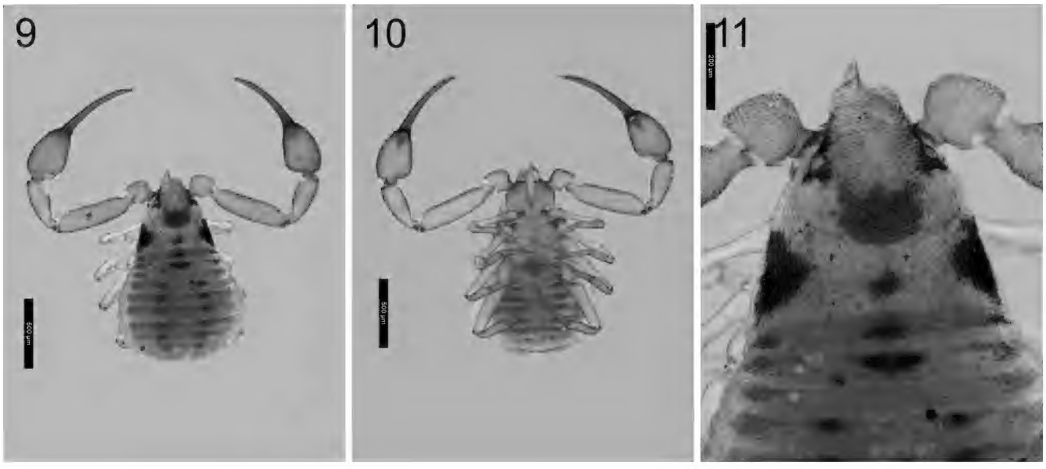
DESCRIPTION

Adults

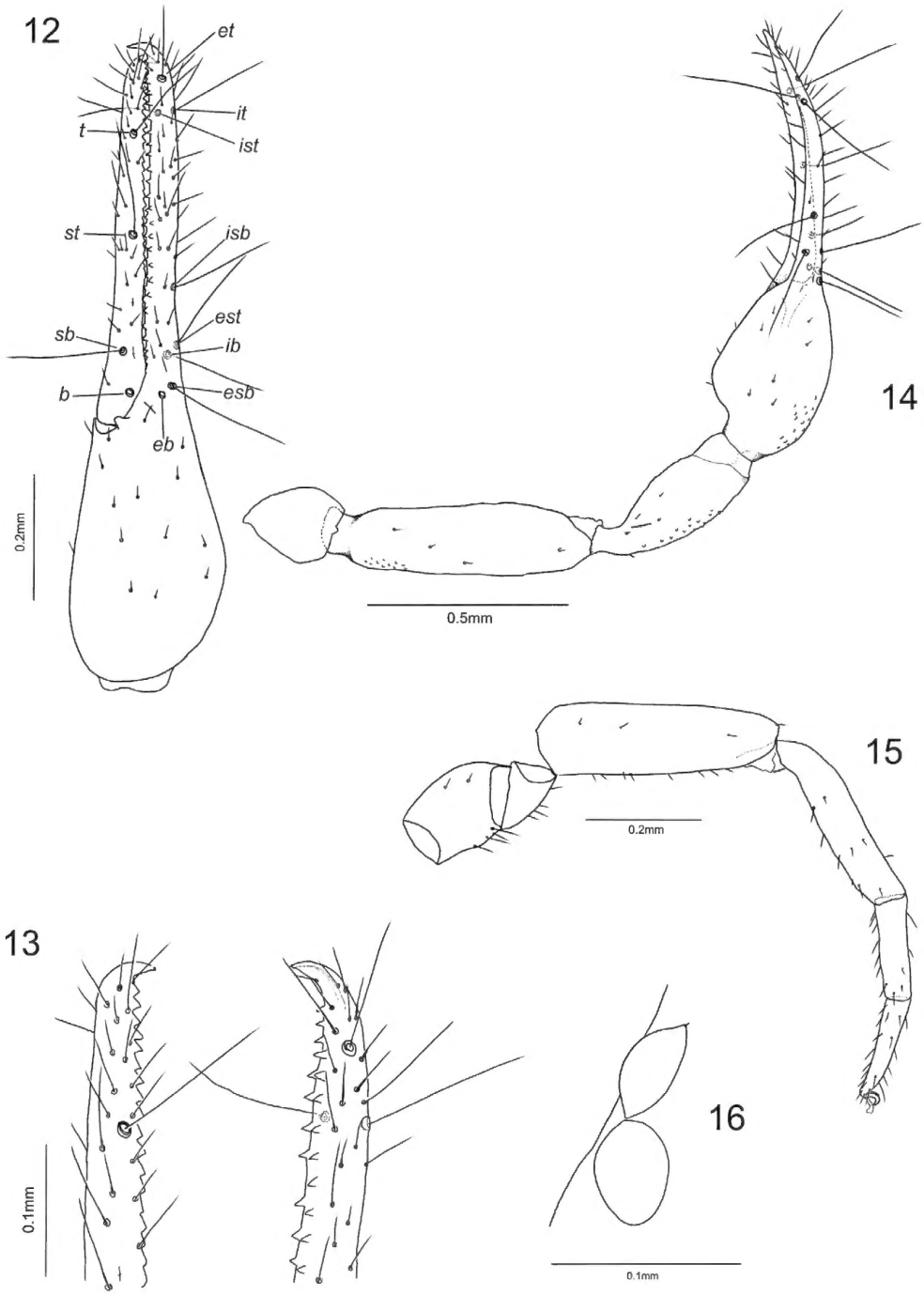
Male only. Colour (Figures 9–11): pedipalps, including trochanter, red-brown; carapace mostly pale with ocular region brown, a large medial brown patch on prozone, paired brown patches laterally on metazone, and a small brown median patch on metazone; tergites generally pale, tergites I–II with darker patches laterally and medially, sublaterally on tergites IV–X; sternites generally pale with paired darker patches on sternites V–X. Setae small and curved.

Chelicera: with 5 setae on hand and 1 subdistal seta on movable finger, all setae acuminate; 2 dorsal lyrifissures and 1 ventral lyrifissure; galea small, triangular and unbranched; rallum of 1 small blade; serrula exterior with 15 blades; lamina exterior present.

Pedipalp (Figure 14): trochanter 1.47–1.48, femur 3.75–3.77, patella 2.79–2.87, chela (with pedicel) 3.59–3.63, chela (without pedicel) 3.50–3.52, hand 1.31–1.48 × longer than broad, movable finger 1.53–1.69 × longer than hand (without pedicel). Fixed chelal finger with 8 trichobothria, movable chelal finger with



FIGURES 9–11 *Geogarypus plusculus* sp. nov., holotype ♂ (WAM T148079): 9) dorsal; 10) ventral; 11) cephalothorax, dorsal.



FIGURES 12–16 *Geogarypus plusculus* sp. nov., holotype ♂ (WAM T148079): 12) left chela, retrolateral; 13) left chelal fingers, retrolateral; 14) right pedipalp, dorsal; 15) left leg IV, lateral; 16) left ocular region, dorsal.

4 trichobothria (Figure 12): *eb* and *esb* situated basally; *est* subbasally; *et* subdistally; *ib* subbasally, opposite *est*; *isb*, *ist* and *it* subdistally; *b* and *sb* situated subbasally, *st* midway between *sb* and *t*. Venom apparatus present in both chelal fingers, venom ducts long, terminating near *isb* in fixed finger and near *st* in movable finger. Chelal teeth diastemodentate; fixed finger with 32 teeth in main row, most strongly curved, the basal teeth becoming progressively smaller, plus 11 curved teeth in prolateral accessory row; movable finger with 33 broad teeth, gap between teeth smaller than breadth of tooth, the distal teeth retrorse and slightly curved, the basal teeth rounded, accessory teeth absent. Retrolateral face of fixed finger with several pit-like structures.

Carapace (Figure 11): 0.87–0.92 × longer than broad; anterior margin slightly indented medially; subtriangular; with 2 pairs of rounded corneate eyes (Figure 16) situated *c.* one-third carapace length from anterior margin; with 4 setae near anterior margin and 11 near posterior margin; with several lyrifissures; with median furrows.

Coxal region (Figure 10): manducatory process pointed, with 3 apical acuminate setae, plus 8 additional setae; medial maxillary lyrifissure situated subdistally; chaetotaxy of coxae I–IV: 6: 6: 7: 13.

Legs (Figure 15): femora I and II longer than patellae I and II; junction between femora and patellae III and IV very angulate; femora III and IV much smaller than patellae III and IV; femur + patella of leg IV 3.65 × longer than broad; metatarsi and tarsi not fused and without tactile seta; subterminal tarsal setae arcuate and acute; arolium longer than claws, not divided.

Abdomen: tergites and sternites without median suture line (Figures 9, 10). Tergal chaetotaxy: 8: 8: 8: 10: 10: 10: 10: 8: 8: 8: 6: 2; uniseriate. Sternal chaetotaxy: 6: (0) 9 [2 + 2] (0): (1) 4 (1): 10: 12: 13: 11: 10: 6: 4: 0. Spiracles with helix. Pleural membrane wrinkled-plicate; with several small curved setae.

Genitalia: lateral apodeme laterally extended and distally broadened; a pair of acute dorsal apodemes; lateral rod very broad ventrally and with a blunt, anterior projection; ejaculatory canal atrium large and cup-shaped.

Dimensions: holotype (WAM T148079), followed by paratype in parentheses: Body length 1.65 (1.46). Pedipalps: trochanter 0.250/0.170 (0.245/0.165), femur 0.620/0.165 (0.585/0.155), patella 0.430/0.150 (0.405/0.145), chela (with pedicel) 0.970/0.270 (0.945/0.260), chela (without pedicel) 0.950 (0.910), hand (without pedicel) length 0.400 (0.340), movable finger length 0.610 (0.575). Carapace 0.575/0.625 (0.530/0.610); eye diameter, anterior 0.054, posterior 0.053. Leg IV: femur + patella 0.485/0.133, tibia 0.325/0.085, metatarsus 0.180/0.055, tarsus 0.177/0.038.

MOLECULAR DATA

The paratype male of this species was successfully sequenced for COI and accessioned in GenBank under Accession No. OK017073 (Table 1).

REMARKS

Geogarypus plusculus has been collected at two locations in Cape Range National Park, Western Australia. Both specimens were collected under rocks.

ETYMOLOGY

The specific epithet refers to yet another species of the genus *Geogarypus* (*plusculus*, Latin, a little more) (Brown 1956).

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